DOE/EIS-0039

FINAL

ENVIRONMENTAL IMPACT STATEMENT

Motor Gasoline Deregulation and The Gasoline Tilt

VOLUME I

January 1979

U.S. Department of Energy

SUMMARY SHEET TO
ACCOMPANY ENVIRONMENTAL
IMPACT STATEMENT
(Pursuant to 10 C.F.R. 208.6(a))

( ) Draft (x) Final

Responsible Agency: Economic Regulatory Administration
U. S. Department of Energy

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1. Type of Actions: (x) Administrative ( ) Legislative

2. Description of Proposed Actions: (1) Deregulation of Motor Gasoline
(2) Allocation by Refiners of Additional Increased Costs to Gasoline

The purpose of the proposed actions is to eliminate regulatory constraints on the gasoline refining and marketing industry. All regions of the country would be affected. No other Federal actions in the area are proposed at this time.

3. Summary of Environmental Impacts: Both of the proposed actions might result in an incremental increase in the price of gasoline of a few cents per gallon and, under expected fuel switching assumptions, some increased use of leaded gasoline in unleaded only vehicles, with some increase in pollution emissions. These impacts are not considered significant. These impacts may be offset in the long run by the favorable effect of the proposed actions on the supply of unleaded gasoline.

4. Summary of Major Alternatives Considered:

(1) No Action (continuation of present regulations)
(2) Control of leaded/unleaded differential at (i) 3 cents per gallon and (ii) 0 cents per gallon
(3) Controls on the price of unleaded gasoline only at the retail level only

5. Parties from Whom Written Comments Have Been Received:

Federal government agencies:

Central Intelligence Agency
Environmental Protection Agency
Federal Grade Commission, Bureau of Competition and Bureau of Economics
General Services Administration
Department of Health, Education and Welfare
Department of Justice
Nuclear Regulatory Commission
Department of the Treasury

States:

California Air Resources Board
The Resources Agency of California
Colorado Office of Energy Conservation
Connecticut Office of Policy and Management
Florida Department of Administration
Michigan Department of Commerce
New Jersey Department of Community Affairs
New York Department of Environmental Conservation
North Dakota State Planning Division
Oregon Department of Environmental Quality
Texas Governor's Office
Vermont State Energy Office, and Bennington County Regional Commission
Virginia Council on the Environment
West Virginia Governor's Office of Economic and Community Development, Fuel and Energy Office

Refiners:

Amoco Oil Company
Atlantic Richfield Company
Chevron, U.S.A., Inc.
Cities Service Company
Continental Oil Company
Exxon Company, U.S.A.
Gulf Refining and Marketing Company
Marathon Oil Company
Mobil Oil Corporation
Shell Oil Company
The Standard Oil Company (Ohio) (Sohio)
Sun Petroleum Products Company
Tesoro Petroleum Corporation
Texaso, Inc.
Union Oil Company

Petroleum Industry Trade Associations:

American Petroleum Institute
National Congress of Petroleum Retailers
National Oil Jobbers Council
National Petroleum Refiners Association
Society of Independent Gasoline Marketers of America
Empire State Petroleum Association, Inc.

Automobile Manufacturer:

Ford Motor Company

Consumers:

Karl F. Anuta
Center for Auto Safety
Samuel Crook (Transcribed by William E. Caldwell)
Kristin Dutton
William Shapiro
George E. Stoertz

6. Comments on DOE's "Analysis Memorandum: 1980 Motor Gasoline Supply and Demand":

Amoco Oil Company
Atlantic Richfield Company
Chevron, U.S.A.
Continental Oil Company
E.I. DuPont DeNemours & Company
Ethyl Corporation
Marathon Oil Company
Nalco Chemical Company
Petroleum Analysis, Ltd.
The Petroleum Energy Group
PPG Industries, Inc.
Shell Oil Company
Sun Petroleum Products Company
Texaco, Inc.
Union Oil Company of California

7. Prepared Statements Submitted at December 19, 1978 Hearing:

John Hamilton, Amoco Oil Company
Jack A. Blum, Independent Gasoline Marketers Council
R. R. Neyrey, Mobil Oil Corporation
Joseph Bryne, Union Oil Company of California
Clarence M. Ditlow III, Center for Auto Safety
Robert A. Pierpont, Jr., Exxon Company, U.S.A.
Ronell Harris, New England Fuel Institute
Pincas Jawetz, Energy Policy Consultant
John Castellucci, Nelson Oil Company
Anthony Prud'Homme, Atlantic Richfield Company

8. <u>Dates EIS Made Available to EPA and the Public</u>:

Draft:	November 20, 1978
Final:	January 30, 1979

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

TABLE OF CONTENTS (Cont'd)

APPENDICES

LIST OF TABLES

LIST OF TABLES
(Cont'd)

LIST OF FIGURES

Page

EXECUTIVE SUMMARY

The Environmental Impact Statement presented here evaluates the environmental impacts, including social and economic impacts, that may result from (1) the exemption of motor gasoline from the Department of Energy's Mandatory Petroleum Price and Allocation Regulations, and (2) the adoption of the gasoline tilt, a proposed regulation that would allow refiners to recover an additional amount of their total increased costs on gasoline. Adoption of the exemption proposal would obviate any need for the gasoline tilt. However, the tilt proposal could be adopted in advance of or as an alternative to deregulation. Therefore, the impacts of the two proposals will be considered separately rather than cumulatively.

A principal reason for adopting either of these proposals is to eliminate the impediments in current regulations that prevent refiners from recovering in the prices charged for gasoline the full amount of costs associated with producing gasoline. Adoption of either proposal may be necessary to encourage increased investments in refining capacity and to prevent shortages of gasoline, particularly unleaded gasoline, after 1980. The gasoline deregulation proposal would also remove regulations on the allocation and distribution of gasoline that are preventing the efficient distribution of supplies and maximum competition. Finally, gasoline deregulation would remove from the refining and marketing industry, and eventually from consumers, the costs and inconvenience of complying with an outdated regulatory program.

Reasonable alternatives to the proposed action which are also specifically addressed in this EIS are:

(1) No action ("no action" as used in this EIS will refer to maintaining the allocation and pricing regulations as they exist presently (January 1979), including the regulation amendment effective January 1, 1979 that allows retail gasoline dealers to pass through their actual increased station rents and the costs of installing EPA-required vapor recovery systems.

(2) Promulgation, concomitant with gasoline deregulation, of a new regulation limiting the amount of retail price differential between leaded and unleaded gasoline sold at the same station.

(3) Promulgation, concomitant with gasoline deregulation, of a new regulation limiting the retail dealer margin on unleaded gasoline.

This EIS analyzes the potential environmental impacts of the proposed actions and their reasonable alternatives and balances these impacts against the ability of the proposals and alternatives to satisfy the foregoing objectives.

The EIS addresses two principal impacts, and several lesser ones. The first principal impact considered is that of the economic changes resulting from changes in the retail price of gasoline. These changes will affect various income groups, regions, and industries differently. Projection of these impacts is developed primarily by extension through 1980 of economic impacts per unit price change that were presented in the Federal Energy Administration's Findings and Views on the deregulation of motor gasoline that were prepared in September 1977. [I-1] The second principal impact relates to those changes in air quality that may arise as a result of incremental use of leaded gasoline in catalyst-equipped vehicles as a result of policy actions of the Department of Energy as they affect quantity, quality and price of gasoline.

Economic Impacts

Between now and 1980, there will be significant increases in the costs of making gasoline that in turn will affect refiner and retail prices for all alternatives, including the alternative of maintaining present controls. These costs increases are due mainly to expected increases in crude oil costs and nonproduct costs and to increased investment necessary on the part of all large refiners to meet the EPA-mandated lead phasedown schedule. Virtually all of these cost increases will occur regardless of which policy option DOE adopts. The principal expected effect of the proposed actions on prices would be only in determining the amount of these increased costs that refiners could pass through on gasoline instead of other products.

The EIS concludes that, if supply and demand remain in balance and certain reasonable assumptions are made about potential crude oil and refinery operating cost increase, under continued regulation prices of gasoline will increase by as much as 9.0 cents per gallon between now and the end of 1980. Under the tilt proposal, the increase could be as much as 12.4 cents per gallon, and under deregulation up to 12.8 cents per gallon.

The incremental price increases under the proposed actions will have direct and indirect economic effects. It is expected that the incremental price increases that would result from the gasoline tilt action would cause the typical family to spend $24 more per year for gasoline. The increase under deregulation would be about $27 per year.

Environmental Impacts

The principal environmental impact resulting from gasoline deregulation is the possible increased emissions from catalyst-equipped light duty vehicles if increased misfueling with leaded gasoline occurs in response to any increases that might occur in the retail price differential between unleaded and leaded regular gasoline.

Methodology

To address the principal environmental issue, the following data were assembled:

(1) Misfueling rate as a function of the leaded/unleaded price differential.

(2) The leaded/unleaded price differential expected to result from the price increases projected for 1980.

(3) Emissions from vehicles with and without poisoned catalysts.

(4) Vehicle miles, population, and miles per gallon by model year.

Each of these sets of data are discussed further below.

Misfueling Rate. The six available studies on misfueling rate were examined for validity. Of the six, three were found to have sufficient content and reliability to warrant their use in this EIS to estimate misfueling rates. One such survey was conducted by General Motors Corporation (GMC) and two by or for the Environmental Protection Agency (EPA). All three show some dependence of misfueling on the price differential (see Chapter III C-3b). Price differentials effects which bound the price differential sensitivity of the three studies are used, with results as shown in Table III C-1.

Price Differential. DOE surveys indicate that the present leaded/unleaded price differential averages 4.4 cents per gallon at full service pumps nationwide, although differentials as high as 14 cents have been observed. There are also differences in price differentials among regions. Each alternative has its own potential consequence on the average retail price difference between leaded and unleaded regular gasoline. The price differential is regulated to 0 cents or 3 cents per gallon in one alternative; under continued regulation the average price differential is estimated to remain in the 4-6 cent range; and under the deregulation, gasoline tilt, and maximum unleaded margin alternatives, the average price differential could, although will not necessarily, increase to a point in the 7-9 cent range. If a significant shortage of gasoline develops (at least 77,000 barrels per day and more likely about 320,000 barrels per day), the average price differential could be greater than 10 cents per gallon, the potential environmental consequence of which is also considered.

Vehicle Emissions. The EPA has developed emissions profiles for vehicles as a function of age which are used for this study. As a catalyst-equipped vehicle ages, emissions will increase, even with a normal catalyst. The EPA study also addresses the amount of emissions if the catalyst is poisoned.

Vehicle Data. Population data for vehicles in calendar year 1980 were taken from projections published by a leading chemical supplier.

These, in turn, are developed from such sources as industry projections and Department of Transportation statistics.

Results

The most observable effect of both the deregulation and gasoline tilt proposals would be to allow refiners full flexibility to allocate expected increased costs among refined products on the basis of their actual costs. In the case of deregulation it would also remove the price controls on retail dealers, thus allowing prices to be set in full response to the market. It is expected that under all of the alternatives the price differential will not increase to a point where an air quality impact can be demonstrated. There is some possibility, however, that under both deregulation and gasoline tilt the average price differential between leaded and unleaded gasoline would increase to a point in the 7-9 cent range. If so, potential increases in vehicular emissions resulting from price differential-induced misfueling could be demonstrated. Under "expected" case fuel switching assumptions, the incremental impact could delay achievement of the National Ambient Air Quality Standards in problem cities by about one-half month for oxidants and one month for carbon monoxide; under "worst" case assumptions, the delays would be about one and two months, respectively. These delays are not significant considering that in any event it will be well into the 1980's before the cities studied will meet present National Ambient Air Quality Standards.

However, the dampening effect on demand of expected price increases under deregulation should reduce vehicular emissions by considerably more than the amount by which price differential-induced fuel switching increases emissions under expected fuel switching assumptions. The offsetting effect will be about twice the incremental hydrocarbon and carbon monoxide emissions resulting from expected-case increased fuel switching, and will be about equal to such emissions under worst-case assumptions.

Also potentially offsetting any adverse environmental consequences of the gasoline tilt and deregulation proposals is the fact that there may be adverse environmental impacts as well if no action is taken. Considerable evidence was received in the comments on the Draft EIS to the effect that existing regulations will inhibit needed future increases in the quantity and quality of unleaded gasoline. Shortages of such fuels will cause motorists to switch to leaded grades in order to obtain adequate supplies. Although the extent of such fuel switching and adverse environmental consequences are impossible to quantify, there are increasing indications that the long-term adverse impacts of the no action alternative could exceed the potential adverse impacts of the deregulation and gasoline tilt alternatives described in this EIS. Deregulation and the gasoline tilt are expected to reduce the possibility of gasoline shortages, especially after 1980, by improving the climate for investment in refinery capacity expansion.

Because it is projected that petroleum refining capacity in 1979 and 1980 could be straining to meet demand (more so than in previous or subsequent years), there is a potential for a gasoline shortfall. Because of lead times involved in making major refinery expansions, none of the alternatives under consideration will have a major impact on supplies in these two years. The existing production capability should be adequate to meet demand if utilized to its maximum, but any unexpected and significant supply interruptions or unexpected increases in demand would likely cause shortages.

The risk incurred in deregulation (but much less so under the tilt alternative) is that price increases unrelated to cost increases will occur in response to any shortage that does develop. In 1980, if it is assumed that there is a supply shortfall such that the leaded/unleaded differential increases to 10 cents per gallon or more, it is estimated that there would be National Ambient Air Quality Standard attainment delays in problem cities of about four months for carbon monoxide and three months for oxidants under expected case assumptions; they would be twice these amounts under the worst case.

Under the proposed exemption action, DOE retains the authority to reimpose gasoline regulations, in whole or in part. Thus, the price impact of a market imbalance might be only transitory, depending upon whether and how soon controls are reimposed. To the extent that additional catalysts are poisoned during a temporary price differential increase, the incremental environmental impact would be present as long as those vehicles with poisoned catalysts remain in use.

I INTRODUCTION

The present regulation of the price of petroleum products traces its origin to the August 15, 1971 price freeze imposed by President Nixon under the Economic Stabilization Act of 1970, P.L. 92-210. The present price control program, however, as well as the companion program regulating the allocation of products, is based upon the authority contained in the Emergency Petroleum Allocation Act of 1973 as amended (EPAA), P.L. 93-159, and the Mandatory Petroleum Allocation and Price Regulations, 10 CFR Parts 210, 211, and 212, issued under that Act on January 14, 1974. (Both the Act and the regulations have subsequently been amended many times.) The purpose of the EPAA was to provide stability to the U.S. petroleum-based economy during a period of crude oil price and supply instability. Those provisions of the regulations relevant to the issues raised in this EIS will be described below at the appropriate point in the analysis.

In general, the price regulations establish a maximum price for a product sold to a class of purchaser based upon the price of that product to the same class of purchaser on May 15, 1973. Provisions are made at the refinery level for passing through additional costs, including increased raw material costs and some increased operating costs such as labor, shipping, and marketing costs. When the competitive market drives the refinery price of a controlled product below the maximum permitted value so as to prevent full recovery of all costs, allowable costs can be "banked" by the refiner for recovery when market conditions permit. At the dealer level, similar but less complicated rules apply.

The allocation provisions of the regulations provide in effect that a supplier of motor gasoline shall apportion to his customers any inability on his part to supply the product in proportion to their historical demand (as measured by their purchases during the corresponding month of 1972). When the supply of product exceeds the requirements of the purchasers, disposal of the excess is at the discretion of the supplier subject to such product first being offered to the supplier's historical customers. Provision is made for new suppliers and for priority customers.

I A Proposed Actions

The Department of Energy has proposed the exemption of motor gasoline from the Mandatory Petroleum Price and Allocation Regulations, pursuant to the provisions of Section 12 of the EPAA (as amended). (This section was added to the EPAA on December 22, 1975, by the Energy Policy and Conservation Act (EPCA), P.L. 94-163.) Deregulation of gasoline would place this product in the same status as middle distillates, residual fuel oil and other products that have already been deregulated -- it would be free from current controls but through September 30, 1981 would be subject to reimposition of partial or full controls, in accordance with DOE's Standby Petroleum Product Price and Allocation Regulations (44 F.R. 3928, January 18, 1979), at any time DOE determines it necessary to carry out the objectives of the EPAA. Deregulation of gasoline, which constitutes about 42 percent of total U.S. refinery output, would leave less than 10 percent of refinery output (including aviation gasoline and kerosene-base jet fuel, which have also been proposed for deregulation) still subject to controls.

The other proposed action being considered in this EIS is the adoption of a final rule that would allow refiners of gasoline to pass through an amount of total feedstock and allowable operating costs that is greater than the amount of costs that would be attributed to gasoline on a volumetrically proportional basis, as required by the present regulations. The allowable amount of the so-called "tilt" to gasoline would be, in the case of crude oil costs, 110 percent of the amount of feedstock costs that would otherwise be allowed on a volumetrically proportional allocation basis. For non-product costs, the tilt would depend on a formula in which the tilt of costs to gasoline would be proportional to the percentage yield of gasoline in the refiner's total product slate. Since price and allocation controls would otherwise continue unchanged under the proposed gasoline tilt action, the gasoline tilt can be accomplished administratively by ordinary rulemaking and is not subject to the provisions of Section 12 of the EPAA.

I B Background

I B-1 Deregulation of Motor Gasoline

The exemption of motor gasoline from 10 CFR Parts 210, 211, and 212 is being considered by the Department of Energy. According to the terms of the EPAA, as amended, DOE may submit an "energy action" to the Congress that will exempt a petroleum product from allocation and price controls, and such action becomes effective at any time designated by DOE if neither the House nor the Senate votes, within 15 calendar days of continuous legislative session after submittal, to disapprove of the action.

On January 19, 1977, following a notice of proposed rulemaking (41 FR 51832, November 24, 1976) and public hearings, the Federal Energy Administration (FEA), a predecessor of DOE, issued two amendments exempting motor gasoline from 10 CFR Parts 210, 211, and 212, the Mandatory Allocation and Price Regulations (42 FR 4416 and 42 FR 4419, January 25, 1977). These amendments were transmitted to the Congress as Energy Actions Nos. 8 and 9 on January 19, 1977. However, prior to the close of the 15-day Congressional review period, President Carter determined that the motor gasoline exemption amendments required further consideration. Therefore, on January 24, 1977, the FEA issued a notice rescinding the January 19 amendments (42 FR 3036, January 27, 1977) and thereby withdrew Energy Actions Nos. 8 and 9 from the Congressional review procedure.

In the April 29, 1977 National Energy Plan (NEP), the President expressed his intention to examine the motor gasoline supply and demand situation with a view to deregulating motor gasoline at the end of the 1977 peak driving season. On August 9, 1977, the FEA gave notice (42 FR 40915, August 12, 1977) of a proposal to exempt motor gasoline from the Mandatory Petroleum Allocation and Price Regulations and a proposed Special Rule No. 4, a transitional motor gasoline assignment program which would remain in effect for the year following the proposed deregulation of gasoline. The FEA invited public comments on the proposals through September 6, 1977, and held public hearings in Washington, D. C. and six other cities on September 6, 7, and 8, 1977.

In September 1977, the FEA issued its "Findings and Views Concerning the Exemption of Motor Gasoline from Mandatory Petroleum Allocation and Price Regulations."[(I-1)] This report provided various findings required by the EPAA in submitting a deregulation proposal to Congress.

On October 1, 1977, Section 301 of the Department of Energy Organization Act (DOE Act, P.L. 95-91) transferred to the Secretary of Energy the authority previously exercised by the FEA Administrator, including the authority to administer the regulations promulgated under Section 4(a) of the EPAA and to exercise the deregulation authority under Section 12 of the EPAA. Section 705(b) of the DOE Act continued, unaffected, the rulemaking proceedings pending before the FEA on October 1, 1977, including the motor gasoline exemption proceeding.

Section 402(c)(1) of the DOE Act provides that the Federal Energy Regulatory Commission (FERC) has jurisdiction to consider proposed amendments which would be required to be submitted to Congress as energy actions under the procedures specified in Section 404 of the DOE Act. Since the FEA had not taken final action on the motor gasoline proposal prior to activation of the DOE on October 1, 1977, after that date the proposal had to be transmitted to the FERC for its consideration before it would be submitted to Congress. The FERC held a public hearing on the proposal in Washington, D.C. on November 29 and 30, 1977, and accepted public comments through December 5, 1977. After completing its consideration of all the information available from these proceedings, the FERC concurred on March 29, 1978 in the proposal to exempt motor gasoline from both the Mandatory Petroleum Price and Allocation Regulations.

After it was modified in two respects from the August 9, 1977 proposal, the FERC also concurred in the issuance of Special Rule No. 4.

In accordance with 10 CFR Part 208, regarding DOE's compliance with the National Environmental Policy Act, an "Environmental Assessment of the Exemption of Motor Gasoline from Mandatory Petroleum Allocation and Price Regulation" was published in the Federal Register on June 24, 1978, with a notice of a public hearing scheduled for July 12, 1978. (The hearing date was subsequently changed to July 14, 1978). The Environmental Assessment concluded that there would be no significant impact caused by deregulation on the quality of the human environment. A supplement updating the "Findings and Views Concerning the Exemption of Motor Gasoline from Mandatory Petroleum Allocation and Price Regulations," dated May 1978, was also released to the public on June 28, 1978.

Following review of the oral presentations at the public hearing on July 14, 1978 and the submission of written comments, and notwithstanding its earlier conclusion that gasoline decontrol will not have significant environmental impacts, DOE decided to prepare an environmental impact statement to consider in detail the impacts that may result from deregulation in comparison with other alternatives that may be initiated. On November 20, 1979, a Draft EIS (hereinafter "DEIS") was issued pursuant to a notice published in the Federal Register (43 F.R. 54125) and a public hearing was held on the DEIS in Washington, D.C. on December 19, 1978. The written comment period closed on January 5, 1979, but late comments have been received and have been fully considered.

This document comprises a final EIS on the exemption of motor gasoline from Mandatory Petroleum Allocation and Price Regulations.

I B-2 Gasoline Tilt

Also being considered by the DOE, in the event the deregulation action is not taken immediately, is a proposed amendment to the present price rules applicable to refiners to allow refiners to pass through more than a volumetrically proportional share of their increased costs in the prices they charge for gasoline. This action, if DOE decides to take it, would be would be in the form of the promulgation of a final rule by the Administrator of ERA.

This so-called gasoline tilt regulation was first proposed by the FEA in a notice of proposed rulemaking issued on February 11, 1977 (42 F.R. 9675, February 17, 1977). Public hearings on the proposal were held on March 8, 1977. This rulemaking was among those that was pending when the DOE was activated on October 1, 1977, and was continued under the jurisdiction of the ERA.

On October 22, 1978, the ERA issued a final rule implementing the gasoline tilt. (43 F.R. 50386, October 27, 1978.) The rule was to have become effective December 1, 1978. However, prior to the effective date, ERA discovered that the FERC had inadvertently not been provided adequate opportunity to review the rule under Section 404(a) of the DOE Organization Act to determine whether it might significantly affect a function of the Commission under Section 402(a), (b) and (c)(1) of the DOE Organization Act. (Section 404, which applies, among other things, to all proposed rules promulgated by the ERA under the EPAA, provides that if the Commission does determine that such a function might be significantly affected, it shall consider the rule in much the same manner as it must consider energy actions for the deregulation of products under Section 402(c)(1) of the DOE Organization Act.) Therefore, on November 24, 1978, ERA issued a notice (43 F.R. 55744, November 29, 1978) indicating that it was suspending the effective date of the rule with the intent to make it effective on January 1, 1979 in order to allow the FERC an opportunity to make the threshhold determination under Section 404(a) of whether the rule might significantly affect one of its functions. On December 14, 1978, the Commission notified the ERA by letter that it had decided not to make such a determination.

ERA was of the view at the time the final gasoline tilt rule was issued on October 22, 1978 that the rule would not result in a significant impact on the quality of the human environment and therefore that an EIS was not necessary. Subsequently, several interested persons raised with ERA the question of whether an environmental impact statement or, at a minimum, an environmental assessment should be prepared on the regulation. Since the DEIS on motor gasoline deregulation also indicated that the environmental effect from both gasoline deregulation and the tilt would be about the same, and since a decision had been made to complete a final EIS on the former, on December 5, 1978 the ERA issued a notice stating that it would also complete a final EIS on the tilt before making a final decision on whether to issue it. (43 F.R. 57609, December 8, 1978.) Since the environmental effect of the tilt had been as thoroughly considered in the DEIS on motor gasoline deregulation (as an alternative to deregulation) as it would have been in a separate DEIS, it was determined, with the concurrence of the Office of Federal Activities of EPA, which oversees NEPA compliance, to include the tilt as a second proposed action, rather than as an alternative, in the final

EIS prepared on motor gasoline deregulation. A statement to that effect was included in the notice of December 5, 1978, and commenters were requested to comply with the same comment period in submitting comments pertinent to a final EIS on the gasoline tilt.

This document therefore also comprises a final EIS on the proposed adoption of a gasoline tilt regulation.

II DESCRIPTION OF PROPOSED FEDERAL ACTIONS AND ALTERNATIVES

II A Exemption of Motor Gasoline from Regulation

One of the proposed actions considered would exempt motor gasoline from price and allocation regulations, and provide rules to ensure an orderly transition to deregulation. Full or partial controls could be later reimposed under Section 12(f) of the EPAA if DOE determines this to be warranted. It should also be noted that even after deregulation (or under any of the other options that may be adopted, including the option of continuing present controls), the President's voluntary price guidelines will apply to all gasoline supplies subject to them.

II A-1 Objectives of Motor Gasoline Deregulation

There are several objectives that DOE hopes to accomplish through motor gasoline deregulation.

First, to the extent that present regulations do not explicitly allow the full recovery of certain costs that would be recoverable in a free marketplace, such as a fair return on equity investments, they are having a chilling effect on new investments in increased or improved refining capacity. This may be so even if refiners are currently not recovering fully the increased costs they are allowed to recover, since investment decisions are considered, first, over the useful life of the expanded or modified capacity, and, second, against other investment opportunities. For most refiners these other opportunities include alternatives where no restrictions of any kind on recovery of costs are applicable. Thus, deregulation should provide an improved climate for investments in refinery expansion and modification, with the result of increased supplies of needed products such as unleaded gasoline and increased ability of the refining industry to process lower quality domestic crude oils, thus lessening our dependence on imports.

Second, deregulation will provide refiners and marketers with increased flexibility in the distribution of their products and enhance competitive opportunities for all segments of the petroleum industry. (See particularly the comments provided on the Draft EIS by the U.S. Department of Justice and the Federal Trade Commission.) Under current regulations, suppliers are limited in their ability, for example, to withdraw from uneconomic marketing areas or to dispose of surplus product. Purchasers, especially nonbranded independent retailers of gasoline, are limited in their ability to find new suppliers of product because of the restrictions of the surplus product rules. Deregulation would tend to free up supplies of product, would eliminate uneconomic price distortions among suppliers and to various classes of customers, and would eliminate inefficient distribution arrangements.

Third, to the extent that regulations are not effectively restraining prices as originally intended, which DOE believes to be the case, they are imposing burdens of compliance on the industry without offsetting benefits to the consumer. Deregulation would free the industry of the costly and probably unnecessary burdens of compliance with ineffective regulations.

II A-2 Motor Gasoline Prices

The existing regulations do not set uniform retail prices but rather establish, in effect, maximum margins for dealers and jobbers over the price paid to the refiner. The refiners in turn are limited to a maximum price related to their prices on May 15, 1973 and increases allowed under the regulations for crude oil and other identified product and nonproduct costs. Under deregulation, both refiners and marketers would be free to establish prices for gasoline at whatever levels they determine will maximize their profits, subject only to competitive market conditions and the provisions of Federal and State antitrust laws.

It should be emphasized that, under present controls, DOE does not directly regulate price differentials between leaded and unleaded gasoline. Consequently, exemption of motor gasoline would not necessarily cause refiners and dealers to change the price of one grade of gasoline relative to another, although, as shall be discussed below, it is predicted that prices of unleaded grades of gasoline will, at least in the short term, rise somewhat faster than prices of leaded grades.

Under current DOE regulations refiners can pass through increased depreciation costs, but there is not explicit allowance for recovery of a return on new investment. Following exemption, refiners would be assured of the opportunity to pass through any return on investment costs that competitive marketing conditions would permit. As will be described in more detail in Chapter IV, DOE estimates that the incremental price increase associated with exemption should be no more than approximately 3.8 cents per gallon (including 7.0 cents per gallon for increased crude oil costs) over what price levels would have been under current regulations. This upper bound estimate is based primarily on the assumption of accelerated expansion and modification of refinery capacity because of the improved climate for investment under decontrol.

Any such investment would begin to be committed as soon as deregulation becomes effective, but substantial expansions or modifications would not become operational until after 1980 because of the lead times required. The qualitative impacts of exemption are not critically dependent upon the exact value of the investment figure.

The EPA and others have expressed concern that deregulation would initiate increased spreads between regular leaded and unleaded grades of gasoline and that there would be a resultant increase in misfueling (the use of leaded fuels in vehicles designed for the use of unleaded fuel only). DOE's price regulations have been focused primarily on unwarranted price increases resulting from shortages.[I-1]

If motor gasoline is exempted from control, DOE will institute a post-exemption system to receive and analyze information regarding both gasoline prices at retail levels, including leaded/unleaded differentials, and the relative market shares of different segments of the industry.[II-1] (See also Chapter V, section A-2.)

DOE retains authority under the EPAA to reimpose controls and will do so if that is considered necessary. When deregulation occurs, the existing regulations automatically revert to standby status and can be reimposed at any time in the event of a supply emergency. In addition, the DOE has recently adopted Standby Petroleum Product Price and Allocation Regulations (44 F.R. 3928, January 18, 1979) that can be activated in the event of a supply interruption. These regulations incorporate many of the features of the present regulations but contain improvements, including authority to impose controls selectively on unleaded gasoline, to make them more effective in dealing with a severe supply shortage. Also, if at any time after deregulation, DOE determines that significant environmental impacts are occurring or are likely to occur as a result of gasoline exemption, DOE will initiate appropriate regulatory or other action, beyond that authorized in the standby regulations, which would have the effect of mitigating these adverse environmental impacts.

II A-3 Supply Allocations

Under allocation deregulation, refiners and distributors would be free to withdraw from marginal marketing areas, to alter current marketing practices, and to modify or terminate present supplier/purchaser relationships. In the event spot shortages occur, it would allow suppliers to react on a more current basis than reverting to 1972 supplier/purchaser relationships, which may not continue to be viable. However, Special Rule No. 4 has been proposed to be implemented concurrently with the general exemption of gasoline and for one year following exemption should guard against the possibility of localized supply shortages and provide an orderly transition to a deregulated environment. In essence, the rule would require the present supplier to continue base period supply arrangements for a period of up to one year with present purchasers who make good-faith but unsuccessful efforts to obtain alternative supply sources.*

DOE had previously concluded that supplies of motor gasoline are adequate to meet demand through 1979.[III-5] A recently completed

* Several states in their comments on the DEIS urged also the continuation of the state set-aside program, which requires each prime supplier into a state to have a small percentage of its total sales into the state available for allocation by state officials if necessary to prevent localized shortages and to meet emergency needs. Such a program was continued after middle distillates were deregulated, and its continuation for gasoline also will be considered by DOE.

analysis of the 1980 situation, on which public comments have recently been received (see 43 F.R. 59541, December 21, 1978 and Appendix F to this EIS), indicates that supplies should be adequate to meet likely demand through that year, although the supply situation will be tight if demand is at the high end of the expected range. (See Chapter III, Section B) Prior to submission of a gasoline deregulation amendment to Congress, the required Findings would address this supply/demand balance issue in detail. The analysis contained in the main text of this EIS considers both a market balance case (that is, supply will meet demand without any increase in the real price of gasoline) and a case where supply will not meet demand without some increase in the price.

In the short run (that is, through 1980), deregulation is not expected to have significant favorable or adverse effect on the ability of the refining industry to meet gasoline demand without increasing prices. This is because lead times of at least two years are required in order to make significant expansions in refinery capacity. However, in the medium and long run (post-1980), it is expected that gasoline deregulation will have a significant favorable impact on supplies of gasoline because refiners will be able to anticipate full recovery (subject to competitive constraints only) of a return on new capital investments.

Therefore, should supply shortages materialize in the first few years after gasoline deregulation, the Federal Government would be faced with the choice of allowing price increases to establish a new supply/demand balance, in which case consumers would have to incur higher gasoline costs as the price of greater gasoline supplies in the future, or reimposing price and allocation controls, which would give consumers temporary price relief but would tend to prolong the shortage.

II B Gasoline Tilt Regulation

The other proposed action considered is a change to present regulations that would allow refiners to pass through more than a volumetrically proportional share of increased costs in the prices charged for gasoline. This proposed action, together with another rule, known as the "rent passthrough rule, which would permit retail gasoline dealers to pass through in their gasoline prices any increased service station rents or vapor recovery system costs they have incurred since May 15, 1973, were considered in the Draft EIS to be a separate alternative to both deregulation and the continuation of present controls. Subsequent to the issuance of the Draft EIS, the rent passthrough rule became effective on January 1, 1979 (see 43 F.R. 60868, December 28, 1978).*

II B-1 Description of the Proposed Action

Since early 1975, refiners have been allowed to pass through in their gasoline prices a proportional share of their total increased costs determined on a volumetric basis, plus those increased costs that are not recovered on other controlled products. The cost of refining gasoline, particularly unleaded gasoline, is considerably higher than the cost of refining other products. Notwithstanding the volumetric allocation, these higher costs could be reflected in a refiner's prices for gasoline, as long as it had the unlimited flexibility to allocate unrecovered costs from other controlled products to gasoline.

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* Upon analysis, DOE determined that implementation of the rent passthrough rule would clearly have no significant environmental effect. The total price increase expected to result from the rule would be 0.2 cents per gallon, assuming competitive conditions would allow even this amount to be passed through, which would have a negligible effect on the leaded/unleaded price differential and no discernable effect on the fuel switching rate.

Most products other than gasoline have, however, been deregulated, and a refiner is not able under the regulations to allocate unrecovered costs from these unregulated products to gasoline. As a result, many refiners are now limited to passing through on gasoline increased costs that are less than the increased costs actually incurred in the production of gasoline.

The gasoline tilt regulation would allow refiners to pass through on gasoline up to a maximum of 110 percent of the amount of increased crude oil costs that would be allocated to gasoline if it were done on a volumetrically proportional basis. In addition, refiners will be allowed to allocate more than a volumetric proportion of nonproduct refining costs to gasoline, also up to a specified maximum determined pursuant to a separate formula adopted by ERA. (For the average refiner, which has a gasoline yield equal to about 42 percent of total refinery output, it would be allowed to allocate to gasoline about 150 percent of the amount it could allocate on a volumetric basis.)

Under this regulation, some increases in overall gasoline prices are likely. However, since the gasoline market is highly competitive, it is unlikely that the full 3.9 cents per gallon immediate price increase that is theoretically possible for the average refiner (that is, the refiner with a gasoline yield of 42 percent and average cost increases) would occur. An average price increase of about 1.6 cents per gallon immediately and another 1.8 cents per gallon by 1980, over and above what would be allowed by current regulations, is the maximum likely refiner price increase expected to result from this regulation (see Chapter IV, Section A). The effect of this increase on the consumer is expected to be offset partially by lower prices than would otherwise be the case for other refined products such as heating oil.[(II-2)*]

* Commenters indicated that implementation of the gasoline tilt regulation would lessen the current subsidization of gasoline prices by other deregulated products such as middle distillates.

II B-2 Objectives of the Proposal

The gasoline tilt proposed action will accomplish some but not all of the objectives of deregulation. It will improve the investment climate for expansion or modification of refineries, since it would give refiners increased flexibility to allocate costs to gasoline, and should therefore result in increased supplies of gasoline. DOE believes there will remain some chilling effect on investments, however, since it still will not explicitly provide for recovery of a return on equity investment, and it may not provide for enough cost reallocation to cause investments in very high cost gasoline production capability. It will also not achieve the objectives of relieving refiners and marketers of the burdens of compliance with largely unnecessary regulations, and it would perpetuate inefficient distribution arrangements and anticompetitive supply and price arrangements caused by the current regulations.

The gasoline tilt proposed action would be available through September 30, 1981, when EPAA control authority expires and the deregulation option would automatically occur unless EPAA controls are extended by Congress.

II C Alternative Actions

Exemption of gasoline and the gasoline tilt are only two of the possible DOE actions. A variety of alternatives, including, of course, keeping the present regulations, can be chosen.

II C-1 No Action

The DOE could decide to continue the present regulations with respect to gasoline. Under this alternative, gasoline prices for refiners and margins for resellers would continue to be regulated, as would supply allocations, until the expiration of control authority under the EPAA on September 30, 1981. For purposes of this EIS, this "no action" alternative will be considered as the continuation of those regulations in effect in January 1979 -- including the recent rent passthrough amendments. This represents a change in this alternative from the Draft EIS, when the rent passthrough regulation had not yet become effective.

The rent passthrough regulation was originally adopted as a companion to the gasoline tilt regulation on October 22, 1978 (43 FR 50662, October 30, 1978). This regulation allows retail dealers to increase their maximum allowable prices to account for actual rent increases and costs of vapor recovery systems incurred since May 15, 1973. Under the old regulation, dealers were allowed to pass through a total of up to 3 cents per gallon increased nonproduct costs, which in many cases was not adequate to allow for full recovery of recent rent increases and for required vapor recovery systems plus other increased operating costs.

The DOE estimates an average permissible increase of about 0.67 cents per gallon in maximum retail selling prices resulting from this regulation.[II-3] Since available data on dealer margins[II-1, III-5] indicates that most stations are not selling gasoline at their maximum price limits, market pressures are expected to control actual increases to less than this value (about 0.2 cents per gallon on the average is expected).

The no action alternative of continuing present controls would, under present law, be effective only through September 30, 1981, when control authority of the EPAA automatically expires.

II C-2 Enforced Price Differential

A principal concern expressed about the complete deregulation of motor gasoline prices is that, if retail price differentials between leaded and unleaded gasoline are increased, there could be an increase in the use of leaded fuels in vehicles requiring unlead fuel (misfueling), with a consequent irreversible poisoning of catalysts and a significant increase in vehicular emissions. This argument assumes that the price differential is a primary motivating factor for misfueling. For this reason, partial deregulation (to the extent of eliminating the maximum allowable price and supply allocation controls but mandating the maximum price differential between leaded and unleaded regular gasoline sales at retail outlets) may be considered as an alternative to full deregulation.

Maintenance of price differential regulations only would on the surface appear to yield many of the benefits of deregulation, without incurring the penalty of increased misfueling, if the price differential motivation assumption is correct. Refiners, distributors, and retailers would be free to set prices for each type of gasoline with only the leaded-unleaded price differential at the pump regulated. This alternative might result, however, in less than full realization of the objective of encouraging maximum investments in refinery expansions and modifications, especially if it were applied at the refiner level, since lack of flexibility in allocating costs among leaded and unleaded gasoline at the refiner level would prevent refiners from taking full advantage of differences in the relative elasticities of demand between these two products in setting prices. In addition, several commenters, including particularly the Department of Justice and the Federal Trade Commission, stated that the effect of price differential controls would be to raise the price of leaded gasoline higher than competitive levels, which in turn would stimulate production of leaded gasoline at the expense of unleaded gasoline, in turn creating unleaded gasoline shortages. (This might be especially true if the differential between unleaded premium and some other grade of gasoline were controlled, but that is not being proposed in this alternative; only leaded and unleaded regular would be involved.) Thus, according to these comments, the regulated differential alternative would produce inefficient market distortions which would among other things stimulate fuel switching.

Two separate sub-options of price differential regulations are considered in this EIS. The first sub-option would fix the retail price differential at 3 cents per gallon, a level which is suggested by some as being the approximate difference in production and distribution costs between the two grades. The second sub-option would require leaded and unleaded gasoline to be sold at the same price, thus eliminating any financial incentive to misfuel.

Since DOE controls on the price differential would be based on the general price control authority of the EPAA, this alternative would also be available until the expiration of the EPAA control authority on September 30, 1981.

II C-3 Control of Retail Unleaded Margin

Under this alternative, the retail dealers' margins on the sale of unleaded gasoline would be regulated to current margins plus some increment to cover estimated recent increases in nonproduct costs. The effect of the regulation would be to inhibit directly a growth in the differential due to raising of the retail margin on unleaded gasoline, and to inhibit indirectly growth in the differential by decreasing the ability to lower the margin on leaded gasoline, the "fighting brand", by recouping losses on unleaded.

This alternative would place the effectiveness of the regulation within a State at the discretion of State officials and would delegate enforcement authority and responsibility to the States. In those States where improved air quality is considered critical and the potential for fuel switching is large, the State would thus have the opportunity to reduce misfueling incentives.

If applied at the retail level only, this alternative would accomplish most of the objectives of decontrol. However, retail dealers would continue to be burdened with compliance with regulation of their margins on unleaded gasoline, even though in most cases they would be selling at margins below the regulated level. In addition, since it is not contemplated that this alternative would apply to refiners, independent retailers would undoubtedly feel unduly burdened by the application of continued price controls on unleaded gasoline only to them.

Unless the authority under the EPAA to regulate dealer margins is extended, this alternative would also expire on September 30, 1981.

II D Other Alternatives Considered

This section discusses alternatives which have been considered but eliminated by DOE as either being unreasonable or as being incorporated in other alternatives.

II D-1 Exemption From Price Controls Only

Exemption from price controls would achieve those objectives of deregulation related to price, although it would tend to perpetuate marketing inefficiencies caused by current allocation controls. As a practical matter, however, it would be difficult to maintain allocation controls if prices were deregulated, since a supplier's increased price flexibility could be used to thwart his supply obligations. Suppliers who preferred not to supply a purchaser to whom they have an allocation obligation could use the exemption from price controls to engage in pricing practices designed to discourage that customer from exercising his allocation rights. Such pricing practices would result in widespread market distortions, economic inefficiencies and interference with normal market mechanisms. DOE is constrained by law to ensure, to the maximum extent practicable, that these consequences do not arise. Exemption from price controls alone thus does not coincide with the objectives of DOE and is not considered a realistic alternative.

II D-2 Exemption From Allocation Controls Only

The alternative of exempting gasoline from allocation controls alone has been seriously considered, and a variation of it may be a reasonable interim option to deregulation. This alternative would do little to further the objective of providing refiners with the incentive to increase investments in refining capacity and increase efficiency. However, it would indirectly tend to ameliorate the price distortions created during a shortage of a particular grade of gasoline, such as unleaded premium, by providing the refiner with greater flexibility to allocate available supply among its customers in a manner that best reflects current requirements. More importantly, the removal of allocation controls only would in general enhance competition among suppliers by providing greater flexibility in the distribution of gasoline. Some states commenting on the DEIS were concerned that refiners freed from allocation controls would withdraw from marginal marketing areas or from production points. However, freed of supply obligations, suppliers would have greater opportunity to be competitive for new and expanded markets. Independent marketers would have increased access to gasoline that is excess to the needs of a refiner's usual customers but which under current surplus product rules must be offered to those customers before being offered to be sold to other purchasers. While there is some reason to be concerned that the removal of allocation controls would cause suppliers to concentrate their sales only in areas where they are most likely to be able to realize their allowable prices under the pricing regulations, on balance, relaxation of allocation controls only would tend to achieve some of the objectives of decontrol and might be a reasonable interim measure. However, for the same reasons that total deregulation is being proposed only after a one-year transitional supply protection program (that is, proposed Special Rule No. 4), removal of allocation controls only would be accomplished with a similar phase-out program.

Removal of allocation controls is not treated here as a separate alternative because removal of allocation controls alone would have an indirect and speculative, but in any event only nominal, impact on the prices of gasoline and particularly the size of the leaded-unleaded differential. The benefits of removal of allocation controls alone would relate primarily to increased efficiencies in the distribution of products and increased competition as a result of enhanced access to available gasoline supplies. Thus, the environmental impact of this potential alternative would not be significantly different from that of the no-action alternative.

II D-3 Maintenance of Price Controls on Unleaded Gasoline at the Refiner Level

As described above, imposition of margin controls on unleaded gasoline at the retail level only is a realistic alternative to deregulation. DOE also considered the alternative of imposing controls on unleaded gasoline at both the refiner and retailer levels. While imposing controls at both levels would forestall unjustified price increases at either level, it would also be a major disincentive at the refiner level to needed investments in unleaded gasoline production facilities. It could also cause significant competitive dislocations among refiners because some refiners produce proportionally more unleaded gasoline than others. Since continuation of refiner price controls on unleaded grades of gasoline only would thus have adverse effects on unleaded gasoline supply enhancement even more severe than the alternative of maintaining controls on all grades, and also would not significantly further the objectives of deregulation, this alternative was rejected as unrealistic.

III DESCRIPTION OF BASELINE CONDITIONS

III A The Vehicular Emission Profile By Year

In order to assess the impact of deregulation on vehicular (light duty vehicle) emissions, vehicle population by model years is needed, including projections for 1979 and 1980. Data for the vehicular population are available from sources such as Highway Statistics published by the U.S. Department of Transportation. These data are assembled and projected in a computer program known as ESCON developed by the Du Pont Corporation (III-1). Data supporting the ESCON program are presented in Table III A-1, and were used in the impact analysis of Chapter IV. However, where ESCON has market shares for unleaded fuel passenger cars of 87-100 percent, for simplicity of analysis the air quality impact analysis assumes 100 percent. The economics and environmental impacts arrived at in this document are not sensitive to this simplification.

Emissions from light duty vehicles have been estimated by the EPA. In general, a given vehicle shows increasing emissions in time as the vehicle ages.

Table III A-2 shows the Federal EPA regulations for vehicular emission (California and high-altitude regulations are more stringent). Table III A-3 shows experienced and projected emissions from light-duty vehicles at various ages.

As the result of comments and suggestions received from EPA (and others) on the Draft EIS, the emissions estimates from failed catalysts have been revised and are now shown in Table III A-4. The EPA Mobile Source Emissions Factors (III-17) contains an appendix with data from which the emissions factors used in this EIS are derived. Tables in this appendix detail emissions from vehicles with "no emissions control ability" which EPA believes represents a lost catalyst. These data are used in this Final EIS, with data (in 10,000 square mile intervals) of the EPA reference interpolated to yield mid-year emissions for vehicles by age. These data are valid for both advanced oxidation and three way catalytic converter systems. The Draft EIS had used emissions factors for failed catalysts based upon a statement by the EPA

Administrator in congressional testimony to the effect that the failed catalyst's emissions would increase by a factor of 7 to 10. The estimates used in the Draft EIS tended to understate the increased emissions from poisoned catalysts on new (1980 model year) vehicles but overstated them for model years 1975-1979.

TABLE III A-1 ESCON DATA FOR VEHICLE POPULATION 1980 [(a)]

Model Year	Survivors* (thousand in 1980)	Miles per Gallon	Miles Driven (Billion)
1980	9,420	17.24	133.9
1979	10,510	16.84	149.4
1978	10,687	16.44	142.9
1977	10,832	16.03	135.2
1976	9,984	15.34	116.7
1975	7,979	13.55	86.9
1974	8,123	11.63	82.0
1973	9,663	12.05	89.0
1972	8,109	12.50	67.9
1971	6,419	12.71	48.6
1970	4,239	13.06	28.7
1969	3,762	12.81	22.5
1968	2,931	13.07	17.5
1967	1,655	13.51	9.9
1966	1,306	14.60	7.8
1965	1,112	14.15	6.7
1964	557	14.25	3.3
1963	319	14.26	1.9
1962	217	14.37	1.3
1961	100	14.38	.6
1960	72	14.28	.4
1959	35	14.30	.2
1958	14	14.30	.1

(a) Light-duty vehicles.

Source: E.I. du Pont de Nemours and Company, Inc.

*Remaining vehicle model year population.

TABLE III A-2 VEHICLE EXHAUST EMISSION STANDARDS
(Low Altitude, Non-California Emission Standards)

POLLUTANTS

Model Year	Hydrocarbons	Carbon Monoxide	Oxides of Nitrogen
Light Duty Vehicles			
Pre- 1968	No Standard	No Standards	No Standards
1968-1969	410 ppm(a)	2.3% mole volume(a)	"
	350 ppm(a)	2.0% mole volume(a)	"
	275 ppm(a)	1.5% mole volume(a)	"
1970-1971	2.2 g/mi(c)	23 g/mi	"
1972	3.4 g/mi(c)	39 g/mi	"
1973-1974	3.4 g/mi	39 g/mi	3 g/mi
1975-1976	1.5 g/mi(d)	15 g/mi	3 g/mi
1977-1979	1.5 g/mi	15 g/mi	2.0 g/mi
1980	0.41 g/mi	7.0 g/mi	2.0 g/mi
1981 +	0.41 g/mi	3.4 g/mi	1.0 g/mi
Light Duty Trucks (less than 6000 lbs.)			
Pre-1975	Same Standards As Light Duty Vehicles		
1975-1978	2.0 g/mi	20 g/mi	3.1 g/mi
1979-1982	1.7 g/mi	17.9 g/mi	2.3 g/mi
1983-1984(e)	0.99 g/mi	9.4 g/mi	2.3 g/mi
1985 +(e)	0.99 g/mi	9.4 g/mi	1.4 g/mi
Light Duty Trucks (between 6001 and 8500 lbs.)			
Pre-1970	No Standard	No Standard	No Standards
1970-1973	275 ppm	1.5% mole volume	"
1974-1978	12.4 g/mi	159 g/mi	15.3 g/mi
1979-1982	1.7 g/mi	17.9 g/mi	2.3 g/mi
1983-1984(e)	.99 g/mi	9.4 g/mi	2.3 g/mi
1985 +(e)	.99 g/mi	9.4 g/mi	1.4 g/mi
Heavy-Duty Gasoline Vehicles			
Pre-1979	Same Standards As Light Duty Trucks (6001-8500 lbs.)		
1979-1982	3.2 g/mi	140 g/mi	13.3 g/mi
1983-1984(e)	2.85 g/mi	29.7 g/mi	
1985(e)			
Heavy-Duty Diesel Vehicles			
Pre-1973	No Standard	No Standard	No Standard
1973	"	1.5%	"
1974-1978	16 g/bhp-hr(f)	40 g/bhp-hr	16 g/bhp-hr(f)
1979-1982	1.5 g/bhp-hr	25 g/bhp-hr	10 g/bhp-hr
1983 +(e)	Same Standards as Heavy Duty Gasoline Vehicles		
Motorcycles			
Pre-1979	No Standard	No Standard	No Standard
1980-1982	5-14 g/km	17 g/km	"
198?	5 g/km	12 g/km	"
1983(e)	0.97 g/km	12 g/km	"
1985(e)	0.97 g/km	12 g/km	0.14 g/km

Source:

a.) emission standard varies with vehicle's cubic inch displacement; using 7-mode driving cycle test

b.) Using 7-mode test

c.) using 1972 FTP (constant volume samples)

d.) using 1975 FTP (CVS)

e.) predicted standards

f.) Standard is for hydrocarbons plus oxides of nitrogen

g.) Data from Reference III-17.

TABLE III A-3 EMISSION FACTORS FOR LIGHT DUTY VEHICLES IN 1980

Model Yr	Hydrocarbon Emission Factor gm/mi	Carbon Monoxide Emission Factor gm/mi
1980	0.27	4.37
1979	1.58	24.09
1978	1.92	28.22
1977	2.24	32.08
1976	2.53	35.69
1975	2.81	39.04
1974	6.88	82.83
1973	7.42	89.03
1972	7.90	94.67
1971	8.34	99.76
1970	8.73	104.29
1969	9.09	108.41
1968	9.43	112.40
1967	12.47	110.6
1966	12.8	112.38
1965	13.12	114.03
1964	13.41	115.59
1963	13.7	117.10
1962	13.97	118.51
1961	14.22	119.86

Source: EPA Emissions Factors

TABLE III A-4 EMISSION FACTORS FOR MISFUELED LIGHT DUTY VEHICLES

Model Yr	Hydrocarbon Emission Factor gm/mi	Carbon Monoxide Emission Factor gm/mi
1980	7.63	57.25
1979	7.85	58.89
1978	8.06	60.48
1977	8.25	61.97
1976	8.44	63.36
1975	8.68	64.67
1974		
↓		

Source: EPA Mobile Source Emission Factors, Appendix E.

III B Gasoline Supply and Demand

At the time of preparation of the DEIS, the Energy Information Administration (EIA) of the DOE had developed preliminary projections of motor gasoline demand through 1980. These estimates were used as part of the analysis in the DEIS. After issuance of the DEIS, EIA completed an analysis of supply and demand for 1979 and 1980 (Analysis Memorandum AM/ES/79-12, December 8, 1978, attached to this volume of the EIS at Appendix F) which the ERA issued for public comment on December 15, 1978 (43 F.R. 59541, December 21, 1978). The new supply projections take into account, among other things, the information received from the refining industry as a result of inquiries and refiner conferences conducted in August and September 1978. Demand projections in EIA's analysis did not change from those given in the DEIS.

A possible range of demand has been developed in the Analysis Memorandum (Table III B-1), and supply capabilities are analyzed for various demand levels. Refining actions required to supply this range of demand without any change in EPA's lead phasedown schedule or alteration of its ban on the use of manganese additives (MMT) in unleaded gasoline are set out in prototypical, but not necessarily all-inclusive, form. Options available to domestic refiners to extend gasoline supplies include higher than usual utilization rates for gasoline refining equipment, use of manganese additives in leaded grades, octane reductions in leaded grades, increased imports of gasoline and gasoline blendstocks, and other similar measures. The expectation is that domestic refiners would exercise these options rather than permit a shortage to develop. However, if actual demand reached the high end of the projected range and refiners could not or did not exercise all of the available options, a supply shortfall could develop.

Therefore, for purposes of this EIS, an analysis will be provided of the potential price and environmental impacts of both supply/demand balance and imbalance in order that the full range of potential consequences resulting from a supply shortfall following deregulation of motor gasoline will be known.

III B-1 Projected Demand

The estimated demand for motor gasoline in 1980 under selected scenarios is shown in Table III B-1. These gasoline demands are obtained from the EIA Short-Term Petroleum Demand Forecasting Model (STPDFM) simulations, using the three separate Data Resources, Inc. (DRI), forecasts of growth in the U.S. economy. The CONTROL 0524 forecast uses annual real GNP growth rates of 4.0, 3.6, and 4.8 percent in 1978, 1979, and 1980, respectively, to derive the short term demand.(III-2) A high economic growth case (OPTIM 0525) projects an annual GNP growth rate of 4.4, 4.0 and 5.0, for the years 1978, 1979 and 1980, respectively, while a low economic growth case (PESSIM 0524) approximates a GNP growth rate of 3.1, 2.6 and 4.8 respectively.

These estimates are adjusted for structural changes such as increased new car efficiency, alterations in compositions of the car fleet, the effects of dieselization of a portion of the light vehicle fleet, and other energy conservation trends, by use of the Light Duty Vehicle Fuel Consumption Model, developed by the Office of Policy and Evaluation, Division of Conservation, of the Department of Energy.(III-3) The "high conservation savings" estimate was arrived at by assuming the STPDFM incorporated new vehicle fleet efficiency through actual performance of 1976 model year vehicles and adjusting for projected increased efficiency in 1980. The "low conservation savings" estimate was determined by making a similar comparison assuming the STPDFM incorporated vehicle efficiencies of the 1977 model year fleet. No judgments are made here as to which is a more likely case.*

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* Firms commenting quantitatively on the demand analysis specified or referred to projections of their own which in general fell in the mid to low points of the EIA range. Some comments also suggested that the EIA-projected range was too high at both its high and low points.

Some commenters also suggested that future demand be projected using later DRI simulations containing lower growth rates to reflect more recent Council of Economic Advisers estimates. As can be seen from Table III B-1, gasoline demand projections are not overly sensitive to real growth rates. For instance, the difference in forecast gasoline demand derived from the OPTIM 0525 and PESIM 0524 simulations is less than 100 MB/D. Incorporating commenters' suggestions would result in even smaller differences. Furthermore, to the extent that using the economic simulations with the higher growth rates results in higher projected demand, a cautious approach has been taken.

The growth in motor gasoline demand through 1980 will be accompanied by a steady shift in market shares (at the rate of one half percent per month) from the leaded to the unleaded grade. Du Pont estimates of respective market shares through 1985 are as shown in Table B-2. (III-1)

Similar estimates for U.S. refinery output only would show unleaded gasoline to be about 1 percent higher than the figures shown in Table III B-2 because gasoline imports are assumed to be entirely of the leaded regular grades.

TABLE III B-1 ESTIMATES OF DEMAND FOR MOTOR GASOLINE UNDER VARYING ASSUMPTIONS AS TO VEHICLE EFFICIENCY AND ECONOMIC GROWTH (millions of barrels per day)

	OPTIM 0525 (high economic growth)	CONTROL 0524 (medium economic growth)	PESSIM 0524 (low economic growth)
High Conservation Case	7.662	7.628	7.584
Low Conservation Case	7.962	7.928	7.884

Source: Energy Information Administration estimates.

Note: These estimates assume no increase in the real price of gasoline. That portion of the price increases estimated in this EIS which are not inflation-induced are so small as to have only a statistically insignificant impact on these demand figures, given the inelasticity of gasoline demand.

TABLE III B-2 ESTIMATED MARKET SHARES (%) OF LEADED AND UNLEADED GRADES OF MOTOR GASOLINE THROUGH 1985

	Unleaded	Leaded Regular	Leaded Premium
1977	25.3	59.4	15.4
1978	33.3	54.4	12.3
1979	41.2	49.1	9.7
1980	49.4	43.2	7.5
1981	56.9	37.4	5.6
1982	63.6	32.2	5.6
1983	69.2	27.7	3.1
1984	73.8	23.8	2.3
1985	77.5	20.8	1.7

Source: Reference III-1.

Note: The 1980 shares in this table differ slightly from those used in the EIA Analysis Memorandum AM/ES/79-12 (p. 30), which are derived from Ethyl Corporation data. The differences are not significant. Actual 1980 market shares will depend, in part, on the level of conservation from fuel efficiency which is achieved. The difference between the high and low conservation case could modify the shares by as much as 5 percent.

Although at least three refiners are now marketing an unleaded premium grade of gasoline, its availability and market penetration has not been explicitly considered in this analysis because it is impossible to determine the market penetration of premium unleaded gasoline during the next two years. Public comments indicated that additional refiners intend to test market the product, and provided individual refiners' estimates of unleaded premium penetration, but they did not provide a means by which to estimate overall future market penetration.

III B-2 Projected Supply

The estimated supply of motor gasoline in 1980 under selected options as used in the Analysis Memorandum is shown in Table III B-3. These supply estimates are obtained from an EIA model of the aggregate U.S. refining industry. The model employs technical data on refinery operations from the Bonner and Moore Refinery and Petrochemical Modeling System (RPMS), a comprehensive mathematical representation of crude oil distillation, downstream unit operations and product blending which treats the United States as a composite of all refineries. A more detailed description of the methodology is given in the Analysis Memorandum at page 25.

The most significant limitation on gasoline supplies during the next few years will be the ability of domestic refiners to produce sufficient quantities of high-octane blending stock to meet both the rapidly increasing demand for unleaded gasoline and the need to increase the octane rating of the total gasoline pool to replace octane improvement formerly provided by lead and MMT additives. Refiners are attempting to develop substitutes for these additives, but there is no assurance that they will be available or approved by EPA for several years, and it is therefore assumed that increases in octane rating must be obtained primarily through upgrading present refinery process operations.

Trends in U.S. petroleum refinery capacity, 1976-1980, are shown in Table III B-4. The table shows an estimated growth in total refining capacity of almost 8 percent between 1977 and 1980, which falls in the mid-point of the estimated growth in gasoline demand (estimated to range from about 6 to 11 percent) during the same period.

However, crude oil distillation capacity is not the primary factor in limiting future gasoline supplies, since the gasoline yield from crude oil will continue to decline, as it has in recent years, as the U.S. crude mix becomes heavier and naphthas are lost in more severe processing. The key to meeting significant increases in the demand for suitable grades of gasoline rests primarily on growth in catalytic reforming capacity, augmented by alkylation and isomerization units, where suitable feedstocks are available.

TABLE III B-3. PROJECTED MOTOR GASOLINE SUPPLY - 1980

	A	B	C	D	E	F
Estimated Production (MB/D)	7162	7265	7284	7454	7662	7662
<u>Options</u>						
Capacity Utilization (percent)	92	94	92	94	94	92
Increased MMT in leaded grades	No	No	Yes	Yes	Yes	No
Octane Shaving (Leaded grades)	No	No	Yes	Yes	Yes	No
Two Unleaded Grades	No	No	No	No	Yes	No
Pool Lead Average (g/gallon)	.59	.59	.59	.59	.59	1.20

TABLE III B- 4. TRENDS IN U.S.PETROLEUM REFINING CAPACITY, 1976-1980[a]
(MB/D)

	PAD DISTRICT (b)							
Year	I	II	III	IV	V	Total Capacity	Operating Capacity	Crude Runs
1976	1730	4141	6518	549	2487	15877	15424	13417
1977	1807	4175	7078	565	2763	16782	16387	14608
1978[c]	1885	4222	7526	593	2963	17315	---	15130
1979[c]	1963	4280	7797	604	3028	17672	---	15905
1980[c]	1998	4348	8082	610	3063	18101	---	16290
Percent Growth								
1980 over 1977	10.6	4.1	14.2	8.0	10.9	7.9	---	11.5

Source: "Trends in Refinery Capacity and Utilization", Office of Oil and Natural Gas Supply Development, U.S. Department of Energy, Washington, D.C., DOE/RA-0010(78), September, 1978.

(a) Averages of January 1 capacity of the given year and January 1 capacity of the following year.

(b) Petroleum Administration for Defense (PAD) Districts.

(c) Estimated

Catalytic reforming feedstocks are primarily straight run, low-octane naphthas obtained from crude oil distillation. The catalytic reforming process yields reformate, which is a high-octane aromatic stream. This can be blended into gasoline to increase the octane, or processed further to yield benzene, toluene, and xylenes, which are used as feedstocks by the petrochemical industry. Petrochemical requirements are estimated to be approximately 10 percent of the total reformate production.*

Alkylation feedstocks require supplies of LP gases obtained from natural gas processors, light unsaturated by-products of the catalytic cracking process, and other light components produced in the refinery. From these are synthesized a high-octane gasoline blendstock called alkylate. Isomerization units are relatively expensive operations which are used to convert normal (straight chain) aliphatic hydrocarbon components to high-octane isomers, suitable for blendstocks to increase the octane number of the gasoline pool.

Catalytic cracking, which converts heavier gas oils to gasoline, is the primary method for increasing the yield of gasoline. In this process, more than 50 percent of the heavy oil feedstock is converted to gasoline fractions with Research Octane Numbers (RON) averaging about 92, which are blended with reformates, alkylates, and naphtha streams from other processes to produce the various grades of gasoline. Unsaturated light hydrocarbons (propylene, butylenes) produced as by-products in the catalytic cracking process are one of the feedstocks to alkylation units.

The scheduled phasedown in use of lead additives, effective October 1, 1979, and the prohibition on use of MMT in unleaded gasoline effective September 1978, will force increased use of reformates and alkylates in the overall gasoline pool, if present octane numbers for unleaded gasoline and leaded regular and premium grades are to be maintained. The use of MMT does remain as a potential option for increasing the octane of leaded gasoline by limited amounts and has been considered as a possible option in the EIA analysis.

The average lead level in 1978 and 1979 is assumed in EIA projections to be about 1.2 grams per gallon of gasoline (total lead divided by total gasoline

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* The petrochemical manufacturers suggested that the Draft EIS failed to account for the diversion of aromatics to the petrochemical industry. To a large degree, refiners are also petrochemical producers and it is expected that such firms will meet their own petrochemical feedstock requirements. It is also anticipated that independent petrochemical producers will be able to obtain required feedstock in a competitive market.

production). This assumption is based on continuation by the EPA of the waivers of the 0.8 grams per gallon lead phasedown for about 75 percent of the refining industry until October 1979. The 1980 supply situation is evaluated using the October 1979 phasedown requirement for large refiners of 0.5 grams lead per gallon, with no waivers granted after October 1979. Because of the small refiner exemption, however, the effective industry concentration is expected to be 0.59 grams lead per gallon in 1980.(III-2)

EIA projections of potential 1980 supply indicate that the lowest projection of 1980 demand (7.584 million B/D under the low economic growth, high conservation case) can be met by the refining industry, given the expected octane levels, full implementation of EPA lead phasedown requirements and the MMT ban, with no major increase in the level of gasoline imports and with normal refinery capacity utilization. At the highest projection of potential demand (7.962 million B/D under a high economic growth, low conservation case), the EIA analysis shows that demand can be met, although octane shaving or increased lead in leaded gasoline would be required.*

Notwithstanding these estimates that the refining industry will likely have the capability to meet the full range of expected gasoline demand in 1980, the possibility of a supply shortage does exist. For example, unexpected refinery breakdowns or fires could cause shortages.** It is also possible, especially under a deregulation alternative, that instead of pushing refining capacity to the limit, refiners could correct a supply/demand imbalance by raising prices. Thus, for purposes of determining potential environmental impact, this EIS will consider the possibility of a supply shortfall made up by price increases. Given certain assumptions about the fuel switching rate at various price differentials and about refiners' and marketers' allocation

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* One major refiner, in commenting on the EIA analysis, stated that his firm would have no trouble meeting the 1980 anticipated demand, that the EIA analysis overstates demand, and that the analysis understates capacity. One supplier of lead additives and some refiners commented that the high capacity utilization factors used for downstream processing units in the EIA analysis could not be sustained, but other refiners indicated that such rates were attainable. Other refiners questioned the attainability of the assumed average import rate of 300 MB/D, which we continue to believe is valid given the fact that this level has been approached in the past for short periods.

** Concern in DEIS comments was expressed over the recent action of Shell to restrict gasoline to 85 percent and the actual or potential supply problems experienced by Conoco, Texaco and Arco. These problems have been only temporary, and serve to show the potential for spot shortages in a tight supply situation, which in the case of Shell was induced by unexpectedly high demand for its premium unleaded grade, coupled with scheduled and unscheduled refinery shutdowns for maintenance.

of price increases between leaded and unleaded gasoline, as explained in detail in Chapter IV, Section A-3, a supply shortfall of 320,000 B/D or more under the deregulation alternative could result in a significant increase in the price differential and in fuel switching. The incremental environmental impact of such a shortfall will therefore be analyzed in Chapter IV.*

The comments received on the Analysis Memorandum offered a variety of views on the projected ability of the refining industry to meet anticipated demand. The general refiners that had done their own analysis considered demand if anything to be slightly overstated by EIA. However, several refiners indicated that if demand is as high as EIA's high demand case, supplies are not likely to be adequate even with the implementation of the options available to the industry, and that the only solution would be relaxation of the current lead phasedown schedule.

Two commenters, Arco and Shell, noted that the EIA supply and demand projections were based upon year-long averages and pointed out that spot shortages could develop during the peak demand periods in the summers of 1979 and 1980. We recognize that if there are supply shortages, they will be manifested during peak periods. However, year-long averages are appropriate for analysis here, because it is expected that the industry can manage peak period demands through inventory buildups and drawdowns. Several commenters indicated that the forecasts of demand would be more accurate if, for example, personal consumption expenditures rather than real national income or the weighted average of full serve and self serve prices rather than full serve only were used. There were many other comments of this type and all have been thoroughly reviewed. While we have found these comments on the methodology to be technically accurate in some cases, the data are not available to incorporate these suggested changes. In any event, the results of the analysis would not be sensitive to these factors.

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* A larger supply shortfall presumably could result in even larger price differentials and fuel switching, but, as will be shown in subsequent discussion, existing data are not sufficiently sensitive to determine increases in fuel switching rates as the price differential increases above 10 cents per gallon. Thus, an emissions analysis of impacts of supply shortfalls causing price differentials substantially in excess of ten cents is not possible. Any prolonged shortfall at such levels without reimposition of controls is unlikely, however, given the President's authority through September 1981 to reimpose controls and the existence of the recently-adopted standby product price and allocation regulations.

The EIA supply balance is attained by assuming the importation of increased volumes of gasoline. The FTC in its comments pointed out that the importation of gasoline, in the event of a shortfall, would raise retail prices even under controls far beyond those estimated in the DEIS for deregulation. We believe this comment is correct in indicating that prices will increase if imports increase, but the total volumes available for import are so small compared to total supply that we believe the FTC has overstated the price effect.

III B-3 Regional Variations

The United States refining capacity by Petroleum Administration for Defense (PAD) District and by state, January 1, 1978, is shown in Table III B- 5. This capacity is highly concentrated in a few states and/or large metropolitan areas. Refineries in Texas, California, Louisiana and Illinois account for almost 61 percent of the total capacity, while refineries in Pennsylvania, New Jersey, Ohio, Indiana, Oklahoma and Kansas account for an additional 21.5 percent.

More than 40 percent of the total U.S. capacity is in PAD District III, primarily in the Texas-Louisiana Gulf Coast Area. In addition to meeting intradistrict needs, Gulf Coast refineries were designed to provide a substantial portion of District I (East Coast) requirements for motor gasoline and distillate fuel oils.

Table III B-6 shows the motor gasoline production by PAD District, in 1977, and the net pipeline, barge and tanker transport between Districts, plus net imports, needed to balance motor gasoline production with demand in each District.

Refineries in District I (East Coast) supplied only about 31 percent of the District requirements in 1977. District III refineries supplied 61 percent of District I needs, while imports, primarily from refineries in Puerto Rico and the Virgin Islands, supplied the remaining 8 percent.

Refineries in District II produced about 84 percent of the District needs for motor gasoline. Net interdistrict supplies received directly from District III were about 10 percent of the total. About 5 percent of the needs were supplied by net exchanges with District I, while net shipments to District IV represented about 1 percent of the District demand.

Motor gasoline production and demand were essentially in balance in District IV. Net shipments of about 10 million barrels into the District from District II were offset by pipeline movements from District IV to District V.

Refining output in District V meets about 94 percent of the District needs. In addition to the receipts from District IV, an additional 10 million barrels were received by pipeline from District III. Net imports amounted to 3.8 million barrels, or about 1 percent of the total needs.

TABLE III B- 5. ESTIMATED UNITED STATES CRUDE-OIL REFINING CAPACITY, BY STATE, AND PETROLEUM ADMINISTRATION FOR DEFENSE DISTRICT, JANUARY 1, 1978
(Thousands of barrels per day, MB/D)

				Total
		PAD DISTRICT 1		
Pennsylvania	- 802	Georgia	- 21	1,847
New Jersey	- 644	West Virginia	- 20	
Delaware	- 140	New Hampshire	- 13	
New York	- 107	North Carolina	- 12	
Virginia	- 53	Florida	- 6	
Maryland	- 29			
		PAD II		
Illinois	- 1,181	Michigan	- 152	4,143
Ohio	- 590	Missouri	- 107	
Indiana	- 577	North Dakota	- 59	
Oklahoma	- 548	Tennessee	- 44	
Kansas	- 456	Wisconsin	- 40	
Minnesota	- 218	Nebraska	- 5	
Kentucky	- 166			
		PAD III		
Texas	- 4,597	New Mexico	- 116	7,310
Louisiana	- 2,098	Alabama	- 107	
Mississippi	- 329	Arkansas	- 63	
		PAD IV		
Wyoming	- 191	Montana	- 157	572
Utah	- 158	Colorado	- 66	
		PAD V		
California	- 2,374	Oregon	- 14	2,981
Washington	- 382	Arizona	- 6	
Hawaii	- 107	Nevada	- 2	
Alaska	- 96			
			U.S. TOTAL	16,853

Source: The Oil and Gas Journal, Vol. 76, No. 12, March 20, 1978. The Petroleum Publishing Company, Tulsa, Oklahoma.

Note: States omitted do not have refineries.

TABLE III. B-6. MOTOR GASOLINE PRODUCTION, NET TRANSPORT, AND DEMAND BY PAD DISTRICT IN 1977

(millions of barrels MMB)

	Refinery Output	Net Pipeline Transport Receipts + (-)	Net Barge and Tanker Transport Receipts + (-)	Net Imports	Demand
PAD District I	237.6	372.3	172.0	69.6	887.5
PAD District II	769.6	96.0	27.3	1.3	894.2
PAD District III	1,065.5	(489.1)	(199.6)	2.9	379.5
PAD District IV	87.8	0.6	-	-	88.4
PAD District V	370.9	20.2	0.3	3.8	395.2
TOTAL	2,567.4	0.0	0.0	77.4	2,644.8
Total interdistrict movements of motor gasoline by barge and tanker					199.6
Total interdistrict movements of motor gasoline by pipeline					625.7
Total transportation of motor gasoline by pipeline					
• inputs to pipeline					2,199.5
• deliveries					2,200.7
• change in working stocks					52.7

Source: "Crude Petroleum, Petroleum Products, and Natural Gas Liquids, December, 1977, Energy Data Reports. Energy Information Administration, U.S. Department of Energy, May 11, 1978.

In 1977, pipeline movements of motor gasoline from refineries to terminals amounted to 2,200 million barrels, of which 625 million barrels were interdistrict transfers. Interdistrict movements by barge and tanker from District III (Gulf Coast) were an additional 200 million barrels.

This large integrated transportation network, plus intradistrict shipping by tank trucks from the refinery and pipeline terminal, form a distribution system to meet specific local and regional needs.

At the present time, state and District demands for unleaded gasoline as a percent of total gasoline demand vary widely, ranging from almost 50 percent in the District of Columbia to only 16 percent in Idaho. California and most of the states east of the Mississippi River are at or above the national average. Greater agricultural use and higher truck population as a fraction of the total vehicle population are believed to be the major factors accounting for the low percentage consumption of unleaded gasoline in West Central, Southwestern, Rocky Mountain, and Pacific Northwest states.

Refineries in District IV are designed to operate on regional crude oils and to serve regional needs. Low population densities have encouraged the development of small refineries serving limited market areas. Deregulation should see a further growth of independent local refineries, because of their lower transportation and distribution costs.

III B-4 Investment in New Facilities

There was considerable evidence presented in the oral and written comments on the DEIS to the effect that the existence of the present regulations was chilling investment in gasoline production facilities. In view of these comments, this section is added to the EIS to examine investment and investment needs.

It has been argued by some that the price control regulations will not hamper increased investment in gasoline refinery capacity, since industry to date has been able to keep up with the dramatic increases in unleaded gasoline demand despite the existence of controls for the past several years. On the surface this would appear to be true. By comparing the clear pool octane of 1973 (summer = 87.9) to 1977 (summer = 88.0), it can be seen that the downstream capacity needed to maintain octane levels has kept pace with the increased demand for gasoline and the lead phasedown requirements to date. Table III B-7 compares 1970 and 1978 refinery capacities for various refinery operations. It can be seen from this table that the operations related to gasoline have increased as refinery capacity in general has increased, whether by debottlenecking or by new construction (thermal cracking, the exception, is being replaced by more efficient cracking operations). By these two measures, investment in gasoline production facilities would appear on the surface to have not been restricted by regulations.

However, this analysis overlooks the extent to which the industry has to date been able to utilize for the production of unleaded gasoline the gasoline reforming capacity that was installed to make premium leaded gasoline, demand for which has been falling steadily since 1972. Figure III B-1 presents a graph of the sum of experienced or projected unleaded and premium gasoline sales by year. It is evident from this chart that reforming capacity in the interval 1969 to 1977 needed only to remain constant, because increased sales of unleaded gasoline, accompanied by decreasing sales of leaded premium gasoline allowed equipment already in place to be used without further additions. (The reforming capacity growth shown in Table III B-7 therefore represents only about 2 years growth in required capacity).

TABLE III B-7. REFINERY GROWTH, 1970-1978

	Crude Capacity MB/D	Thermal Operations MB/D	Catalytic Cracking MB/D	Catalytic Reforming MB/D	Catalytic Hydro-Cracking MB/D	Catalytic Hydro-Refining MB/D	Catalytic Hydro-Treating MB/D	Alkyla-tion MB/D	Aromatics/ Isomeriza-tion MB/D
Data for plants whose crude capacities have decreased*									15 plants
1970	1046	11.5	380.9	209.4	35	14	184.7	63.7	0
1978	472	0	203.8	102.2	0	0	128.1	22.5	0
decrease	574	11.5	177.1	107.2	35	14	56.6	41.2	0
% decrease	54.9	100	46.5	51.2	100	100	30.6	64.7	0
Data for plants whose crude capacities have remained the same*									5 plants
1970	379	0	139.2	99.6	0	0	88.4	16.1	0
1978	379	0	139.2	95.0	0	0	128.8	25.5	2.3
change	0	0	0	-4.6	0	0	+40.4	+9.4	+2.3
%	0	0	0	-4.62	0	0	+45.7	+58.4	--
Data for plants whose crude capacities have increased 0 to 20%*									52 plants
1970	4912	98.6	1811	1062	256.9	119.7	892	312	59.7
1978	5368	40.3	1880	1271	309.9	194.7	1250	335	62.1
increase	456	-58.3	69	209	53.0	75.0	358	23	2.4
% increase	9.28	-57.0	3.8	19.7	20.6	62.7	40.1	7.37	4.02
Data for plants whose crude capacities have increased 20 to 40%*									24 plants
1970	2186	19.3	893	446	59.2	124.5	506	147	30.8
1978	2955	97.5	1015	625	98.4	113.4	809	195	33.3
increase	769	-1.7	122	179	39.2	-11.1	303	48	2.5
% increase	35.2	-1.7	13.7	40.1	66.2	-8.92	59.9	32.7	8.12
Data for plants whose crude capacities have increased more than 40%*									65 plants
1970	3277	22.9	1052	731	221.3	55.8	735	186	17.1
1978	7253	4.0	1626	1580	355.0	307.2	1816	292	19.3
increase	3976	-18.9	574	849	133.7	251.4	1081	106	2.2
% increase	121.3	-82.5	54.6	116.1	60.4	450.5	147.1	57.0	12.9

* Only plants of 20,000 B/D crude capacity or more were entered in this analysis.

However, Figure III B-1 also demonstrates the need for significant and continuing investment in increased reforming capacity far past the expected flattening of total (both leaded and unleaded) gasoline demand in 1982-1983. Further, it illustrates that the investment needs for reforming capacity have just begun and will slope steeply upward over the next five years or more. Finally, the requirements of octane improvement due to lead phasedown (an increase of 1.5 octane number (research), as shown in Appendix E) add further to investment needs. In short, the increases in downstream gasoline refining capability that have been made under the period of controls are small compared to the increases that must still be made to meet unleaded gasoline demand into the 1980's.

It has not been possible to demonstrate unequivocally that investment has been chilled by the regulations. The extremely high downstream capacity utilization of refineries in recent years (92 percent or more on a regular basis, which for many refineries is the practical limit of capacity) demonstrates that investment needs have not been satisfied in the recent past*, and projections of the future show a definite and significant need for further investment in reforming capacity. This is investment the return on which cannot, under current regulations, be passed through in gasoline prices.

* It is not possible to determine the extent to which capacity extensions have been deferred due to regulations; certainly the extreme inflation and interest rates of recent years have made maximum use of existing equipment preferable to new investment. One refiner in its comments indicated that its recent investments in increased refining capacity were made in the expectation of deregulation of gasoline.

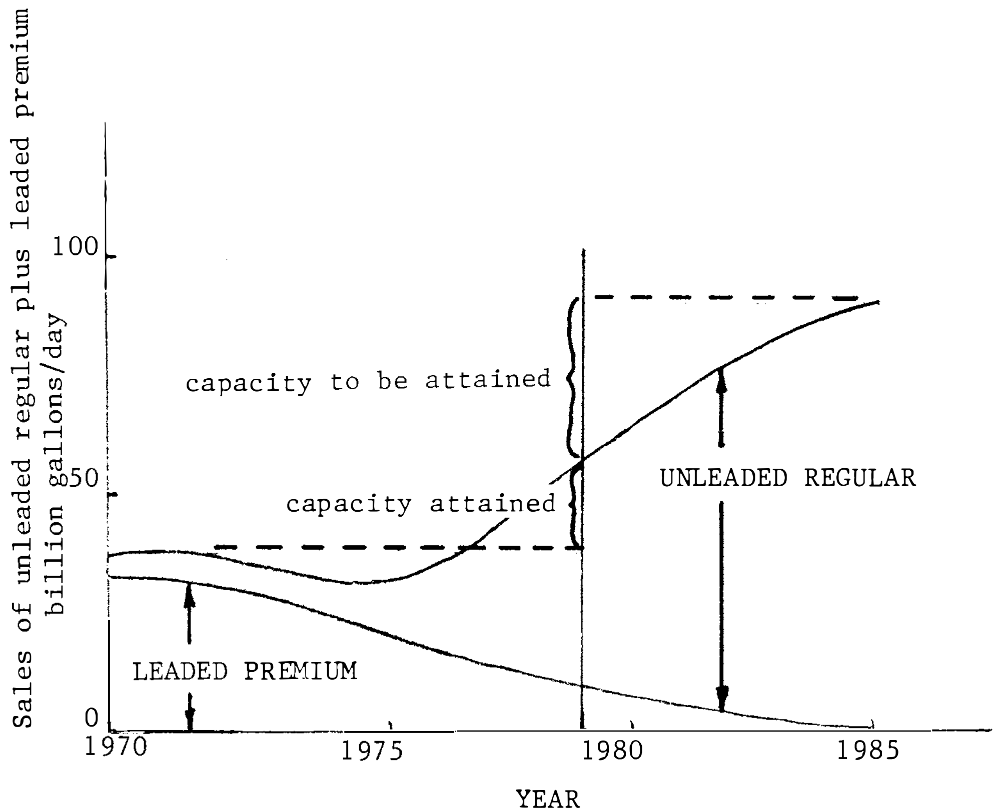

Figure III B-1. Sales of octane-improved gasoline by year.

III C Consumer Fuel Switching Behavior

Most vehicles designed for unleaded gasoline have catalytic converters* for emissions reduction. The catalyst becomes poisoned or inactive when lead is introduced. If a significant proportion of American motorists were to engage in misfueling, the environmental quality objectives intended to be achieved through introduction of catalytic converters will not be met.

* As EPA pointed out in its comments, there are a few vehicles that do not have a catalyst but are certified for unleaded gasoline use because of engine design characteristics.

III C-1 Legal and Operational Aspects of Fuel Switching.

III C-1a Legal Aspects. Fuel switching on the part of a service station proprietor, fleet owner, or his employees is illegal. EPA regu-ations state that

> After July 1, 1974 no retailer or his employee or agent and after January 31, 1975 no wholesale purchaser-consumer or his employee or agent shall sell, dispense, or offer for sale gasoline represented to be unleaded unless such gasoline meets the defined requirements for unleaded gasoline in 80.2(g); nor shall he introduce, or cause or allow the introduction of leaded gasoline into any motor vehicle which is labeled "unleaded gasoline only," or which is equipped with a gasoline tank filler inlet which is designed for the introduction of unleaded gasoline. (10 CFR 80.22.).

The maximum penalty is $10,000 per violation. However, size of business is considered in the EPA procedures, and a retailer would generally be fined a maximum of $1,000 for violation. These regulations are difficult for EPA to enforce since there are approximately 170,000 gasoline stations in the U.S. and half as many again other retail gasoline outlets.

There is no Federal penalty for switching which applies to individual motorists. Some states and localities have laws pertaining to switching. For example, New Jersey and several cities have mandatory vehicular inspection programs in which emissions are tested and those vehicles which do not meet standards must be brought into compliance. Other states* have legislation prohibiting modification of pollution control devices. In Wisconsin, for example, it is in violation of the law to make inoperative a motor vehicle air pollution control system. As of this writing there is no widespread state prohibition against fuel switching by individual motorists. There are other sanctions which may apply. For example, new vehicle warranties may become invalid if misfueling is detected, although the cost of testing a catalyst to determine if it was deactivated by the introduction of lead may cost the manufacturer more than replacement of the catalyst.

III C-1b Mechanical Aspects. Vehicles equipped with catalytic converters have restricted fuel intakes which will permit introduction of gasoline from the narrow nozzles (0.840 inch) which dispense unleaded gasoline. Regular or leaded gasoline pumps are required to have wide nozzles (0.930

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* EPA listed in its comments that some 34 states have laws prohibiting fuel switching or operating a vehicle with deactivated emission controls.

inch) which will not fit the fuel intakes of vehicles designed for unleaded gasoline. In order to misfuel, the fuel intake must be modified, or the motorist must use an adapter (funnel-like device), the regular nozzle on the leaded gasoline pump must be narrowed, or the tank must be filled in some other manifestly inconvenient fashion.

III C-1c Operational Disadvantage of Misfueling. It is believed two consecutive misfuelings can cause the permanent poisoning of the catalyst. In addition to increased emissions of hydrocarbons and carbon monoxide, misfueling causes lead buildup on spark plugs and valves and consequent detuning. One misfueling will cause some temporary loss in effectiveness of the catalyst, but will ordinarily not result in permanent deactivation.

III C-1d Operational Advantage of Misfueling. Leaded regular gasoline usually costs motorists less than unleaded regular gasoline and, because of its higher octane value, may reduce engine knocking and other problems such as run-on (dieseling).*

III C-2 Consumer Motivations

Prior to the 1975 model year of automobiles and light trucks in the U.S., consumers could respond to the price/performance decision in a direct and predictable way with no consideration for legality and little concern for impact on environmental quality. Consumers could improve vehicular performance simply by purchasing a higher grade (octane) of gasoline at a premium price.

This section is concerned with consumer motivation and the decision to purchase unleaded or leaded gasoline. The decision whether to switch fuel is embedded in a series of other decisions the gasoline consumer must make and cannot be couched simply in terms of price of fuel or perceived quality of performance. Therefore, the general phenomenon of gasoline purchasing behavior is addressed first. Secondly, the specific case of fuel switching is considered.

III C-2a The Consumer's Gasoline Purchase. Consumer behavior is not set. Consumers can and do express changing preferences at the market place.

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* The DEIS also stated that hesitation and hard starting may result from the use of unleaded gasoline, which is, according to EPA's comments, not likely true, even though some motorists believe it.

Consumer behavior, however, is patterned: people establish patterns of behavior which preclude confronting routine situations with new decisions. Purchase of gasoline is a case in point. Many people tend to purchase gasoline routinely, and to establish patterns of purchase.

Factors which enter into the gasoline purchase decision are many. Gasoline purchasing is a weekly or more frequent occurrence for many motorists. Driving routes are set by the trip to work and return, and for shopping.* People tend to establish patterns of gasoline purchases based upon convenience or accessibility along frequently traveled routes.

Brand selection and loyalty are factors. Advertising of brands tends to establish in consumers' minds an identity of brand names with other factors such as quality, performance, dependability, service and price. Brand selection, convenience and deferred cash outlay come together when oil company credit cards are used as a form of payment.

Personal considerations enter into the gasoline purchase decision. People may purchase gasoline from a certain retailer because of past or anticipated future transactions. Gasoline may be purchased at a particular outlet because of services offered by the retailer, such as tire repairs and changing, mechanical work or emergency service.

Type of service offered at the retail outlet is a consideration in retail gasoline purchase. Some outlets offer full service, some offer limited service, and some offer self-service. Others offer a choice of service type, ranging from full to self-service, the so-called split island approach.

The several factors which enter the gasoline purchase decision have different priorities for different people. Clearly, any one factor does not predominate. Certain people purchase primarily because of brand loyalty, others because of price, some for convenience, others for service, and some for a combination of factors. And where one factor predominates for an individual, other factors are also involved. In the highly competitive retail gasoline market it becomes inconvenient to go too far out of one's way to purchase strictly for price, brand, service or other single factor.

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* California commented that gasoline purchases are determined primarily by habitual driving routes.

When a motorist pulls into a retail gasoline outlet to refuel, a varied set of factors come into play, a series of trade-offs have been made, and have been incorporated into the behavior.

The introduction of the catalytic converter and concomitant vehicular and legal requirements for unleaded fuel have added a level of complexity to consumer gasoline purchase decision-making. The decision to switch or not to switch from unleaded to leaded is circumscribed by this prior set of decisions and circumstances, and must be considered within that context.

III C-2b The Decision to Switch or Not to Switch. The primary consumer motivating factors which bear on continued use of unleaded gasoline in catalytic-equipped vehicles or switching to leaded fuel are legal considerations, environmental concern, performance of the vehicle, and price of the product. Another item, not necessarily a motivating factor but one which needs to be considered, is consumer confusion.

Legal Considerations. Behavior within the confines of the law is more widespread when the law is perceived as being reasonable and fair, equally applicable to all, and in both the individual and collective interest. Important are perceived consequences of the action, both in terms of sanctions which may be levied, and in terms of perceived damage or harm to self or others as a consequence of violation. Also, the extent to which others adhere to and voice approval of the rule is important in determining behavior. Last, the possibility of detection plays a role.

The legalities of switching from unleaded to leaded gasoline contain certain factors: the retailer is liable for a penalty but the motorist is not. The regulation places the retailer and his employees in the position of policing motorists who either request leaded to be introduced into vehicles requiring unleaded gasoline, or those who actually attempt to do so at self-service pumps. There are two anticipated consequences of the regulation as it presently stands.

Some retail outlets will actively guard against misfueling, and do so at the risk of losing the business of motorists who demand leaded gasoline in vehicles labeled for unleaded only. Other retail outlets will, if not actively engaged in the practice, condone misfueling so as to not lose customers.

Motorists are likely to be confused by and may tend to disregard a rule which, in effect, prohibits the sale but not the purchase of a product. Therefore, the decision by a motorist who is motivated to misfuel is not likely to be overly influenced by the regulation prohibiting introduction of leaded gasoline into vehicles with catalytic converters. But the admonition on the label near the fuel intake stating "unleaded gasoline only" is a reminder enough to those who are not motivated to switch from unleaded to leaded.

Environmental Concern. Nationwide introduction of the catalytic converter and the unleaded gasoline requirement are designed to meet environmental objectives. The extent to which the environmental objectives are to be met depends on individual conformity to the unleaded fuel requirement. The success of the Nation's program to control vehicular air pollutants is contingent upon refueling decisions by individual motorists. If motorists comply, the environmental objectives will be met. However, EPA officials have estimated that emissions from the catalyst-equipped fleet will increase an estimated 30 to 70 percent if 10 percent of the motorists misfuel.[III-5]

Direct environmental incentive for motorists to continue use of unleaded gasoline is lacking for two reasons. The types and amounts of emissions controlled by catalytic converters are not visible, so immediate environmental feedback of the effects of proper or improper fueling is lacking. Lack of perceiveable feedback is also important in that others cannot tell if a motorist has misfueled a vehicle, one can be a "secret switcher" and be undetected (except, perhaps, in the few jurisdictions requiring emissions inspection).

The second reason for lack of direct environmental incentive to continued use of unleaded fuel is that each individual motorist is only one of many and therefore may not consider his individual behavior to have a significant impact on the environment.

Performance of the Vehicle. There were numerous comments received on the Draft EIS to the effect that late model vehicles suffer performance problems with unleaded regular gasoline, which has a lower octane rating than regular leaded gasoline. Even off the production line, some fraction of vehicles suffer performance problems using the marketed unleaded gasoline. As vehicles age, the fraction of vehicles with performance problems increases, with octane requirements increasing until about 17,000 miles.

Vehicular performance is of high priority to American motorists. Any problem of difficult starting, stalling, hesitation, knocking or dieseling is likely to result in a search on the part of the motorist for a solution. In the search for a solution, the motorist has several options, including changing brands of gasoline, getting an engine tune-up, "detuning,"* seeking higher octane unleaded gasoline, or switching to leaded gasoline.

Motorists may follow a sequence of options. If performance suffers, it is convenient to change brands or grades on a trial basis to determine the effects. Then, if poor performance continues, the motorist may have the vehicle mechanically inspected and tuned. Alternatively, the vehicle may be detuned, or the motorist may seek premium unleaded gasoline, available at limited locations in some areas.

At some point in the sequence of the decision-making process switching may occur, but switching generally cannot be an impulse decision. Switching involves modification of the gasoline tank intake, purchase of an adapter or funnel, or finding a leaded pump with a narrow nozzle.

The switch from unleaded to leaded gasoline may or may not improve vehicular performance. But from two up to several tankfuls of leaded gasoline will deactivate the catalytic converter. Even if a motorist finds that performance is not improved and returns to continued use of unleaded gasoline, the converter may have been permanently poisoned. And it is possible that the motivation in the initial switching may be for performance but continued misfueling may be for reason of price.

Price of the Product. The current average price differential between unleaded and leaded gasoline in the U.S. is approximately 4.4 cents per gallon for full serve and 5.2 cents per gallon for self-serve (DOE Monthly Energy Report, December 1978, preliminary figures) but the

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* Retarding of the spark to reduce knocking at the expense of acceleration ability. This results in a concomitant reduction in fuel economy.

differential varies from station to station. (The Center for Auto Safety questioned the Draft EIS figures on what the present differential is and provided its own survey data for the Washington, D. C. area plus national figures provided by the Lundberg Survey. The Draft's figures, as updated here, have been determined by a random survey of retail dealers throughout the country on a regular basis by DOE's Energy Information Administration and are considered by that agency to be more statistically reliable than any other survey data currently available. The standard deviation in the differential among stations is approximately 1.9 cents per gallon; that is, 66 percent of the stations have differentials in the range from 2.5 to 6.3 cents per gallon. At the extremes, both negative differentials and differentials as high as 14 cents have been observed.

At a 4.4 cents per gallon differential, the motorist who drives 10,000 miles per year in a vehicle which obtains 14 miles per gallon will pay approximately $31 more to use unleaded gasoline.* But motorists thinking in percentage terms may attach greater significance to the difference.

The purchasers who set the highest priority on price in their gasoline purchasing decision are of three types. First are those who are willing to pay only the lowest price for fuel. People who do so will almost surely misfuel, since leaded gasoline costs less than unleaded. Second are those who seek the lowest price within mechanical constraints, and third are those who seek the lowest price within regulatory constraints. The people in the last group will be unwilling to adapt the fuel intake restrictor and will seek only the lowest price of unleaded gasoline. Price conscious consumers with environmental concern also fall in this category.

EPA commented that consumers will be influenced in their fuel switching behavior by the price of gasoline breaking through the "decade points" -- that is, when it exceeds 70 cents, 80 cents, etc. The argument is that such breakthroughs will create the psychological appearance for consumers of a higher leaded/unleaded differential than will actually exist, thus causing a higher fuel switching rate. If there is such an effect, it is impossible to quantify. It might also be noted that the decade-point psychology, if it exists, could work both ways. Dealers would also be reluctant to break the decade points when they raise prices, thus perhaps temporarily keeping the price lower than it would otherwise be.

* The Center for Auto Safety referred to a Society of Automotive Engineers paper which cites maintenance benefits of 5¢ per gallon for the use of unleaded gasoline, a benefit which exceeds the cost.

Consumer Confusion. Consumers may be somewhat confused by the issues surrounding introduction and use of unleaded gasoline. Unleaded gasoline costs more than leaded, and some consumers may think of it as a premium quality grade of gasoline for this reason alone, even though leaded gasoline may improve vehicular performance.

Engine manufacturers indicate it is acceptable to use unleaded gasoline in an engine designed for the leaded product, as long as an occasional tank-ful of leaded gasoline is also used to lubricate the valves. Consumers may also believe the reverse to be true.

It is suspected that the "noise" factor in the data is high with respect to misfueling, since the consideration of price, performance, legality and environmental consequence have been left to each individual motorist in the United States to comprehend and work out.

III C3 Composite Model Development

Fuel switching behavior is a function of the price of fuel, of vehicle age, and of vehicle performance. The results obtained here are based entirely on the findings of the following*:

- Environmental Protection Agency (EPA), Mobile Source Enforcement Division's "Fuel Switching Analysis"(III-6)
- General Motors Corporation, "Fuel Usage Survey"(III-7)
- Exxon Company, "Fuel Switching Test Study"(III-8)
- Canadian Air Pollution Control Directorate's study of fuel switching(III-9)
- New Jersey Department of Transportation's study of fuel tank intakes(III-9)
- California Air Resources Board's study of fuel switching(III-9)
- Amoco's questionnaire study of fuel switching(III-10)
- EPA's "Analysis of the Factors Leading to the Use of Leaded Gasoline in Automobiles Requiring Unleaded Gasoline"(III-11).

In line with the objectives of this EIS, the findings of the above-mentioned studies have been examined and the information which addresses

* The State of Oregon brought to our attention that it has surveyed vehicles inspected in Portland's mandatory inspection program and found that two percent of the vehicles had been tampered with in a way that would facilitate fuel switching. Because the tampering rate may be much less than the fuel switching rate, and because the study was confined only to one metropolitan area, we have not used it as a means of determining national fuel switching rates.

most directly and thoroughly the questions considered here have been aggregated and used in formulating the results. Before considering those results, the basic results and information available from each of the above studies should be enumerated.

EPA's Mobile Source Enforcement Division has been engaged in a continuing survey of the refueling practices of motorists in almost every state in the U. S. for approximately the last year. Besides observing the incidence of fuel switching, information was also gathered on the relative fuel prices, on the grade of leaded gasoline to which the switch was made, and on whether the switching was occurring at self-serve or full-serve fuel pumps. The basic results of this EPA study, based on the observation of approximately 1,000 unleaded vehicles (that is, vehicles equipped with catalytic converters), are that fuel switching occurs at a rate of approximately 10 percent (that is, one in every ten unleaded vehicles observed refueled with leaded fuel) and that there does not seem to be any strong relationship between the fuel switching rate and the price differential between unleaded and leaded fuel.[III-6]

Recently, the General Motors Corporation also conducted a study of vehicle refuelings. Information was obtained on not only the rate of fuel switching but also on such things as the year of manufacture of the vehicle, the miles driven by the vehicle, the condition of the filler neck restrictors, the fuel prices, and the grade of fuel to which a motorist switched. This study was done only at self-service pumps and was restricted to late model (1975-1978) General Motors vehicles. The results differ greatly from the EPA study. Primarily, they are that the fuel switching rate is approximately 2 percent, that there seems to be a weak (not statistically supportable) positive relationship between the fuel switching rate and the price differential between unleaded and leaded fuel, and that there appears to be a strong relationship between the fuel switching rate and vehicle age. These findings are based on the observation of approximately 1,200 unleaded vehicles.[III-7]

The Exxon Company did a study on fuel switching which was similar in some ways to the previously cited EPA study. However, only a brief summary of the analysis is available for this report. Observations were made of approximately 2,700 vehicles which refueled at Exxon stations, most of which were self serve only, in nine cities. At each observation the vehicle registration and the type of fuel purchased was noted. The registration was checked with the state's Department of Motor Vehicles to ascertain the vehicle's make, model, and (sometimes) engine size so that the fuel requirements for the observed vehicle could be deduced. Having done this, the unleaded vehicles were identified and the fuel switching rate was estimated by determining how many unleaded vehicles had been observed buying leaded fuel. There are a few possibly serious problems concerning the misidentification of a vehicle which might be associated with a sampling procedure such as this. (See the later discussion of the above EPA study for some of these problems.)

The Exxon study estimated the fuel switching rate to be 10 $\pm$ 2 percent with 90 percent confidence.* No information is available on the price differential between unleaded and leaded fuels, on the age of the observed vehicles, or on steps taken by the Exxon Company to avoid or correct for any misidentification problems.[III-8]

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* Note: The 2 percent range implies that on the order of 600 unleaded vehicles were observed.

In addition to the three above-mentioned studies, sketchy results from three other observational surveys have been considered. These surveys with their results are the following:(III-9)

- The Canadian Air Pollution Control Directorate observed 1,666 unleaded vehicles in seven Canadian cities. Unleaded vehicles were identified by unleaded fuel markers on the dashboard and by the fuel intake. Before observing at a given station, the station manager's permission was obtained. The results indicate that the fuel switching rate is approximately 6.7 percent and that this rate may be higher for older vehicles.
- The New Jersey Department of Transportation observed the fuel intakes of approximately 1,800 catalyst-equipped vehicles and found only 3 vehicles to have been modified. This may indicate that not many drivers of unleaded vehicles are altering their fuel intakes to accommodate the larger leaded fuel nozzles in states prohibiting such actions and enforcing such requirements. In turn, this result might then indicate that the fuel switching rate is also low in those states. Reliable estimates of the true fuel switching rate are, of course, impossible given only this sketchy information.
- A study by the California Air Resources Board estimates the rate of fuel switching to be 3.4 percent.

III C-3a Contemporary Survey Studies. In contrast to these observational studies, a second type of study considered in this report is the questionnaire survey study. Two studies of this kind were considered.

The Sobotka Survey

The recently completed EPA-sponsored study by Sobotka and Co., Inc. and Market Facts, Inc. (hereafter the Sobotka Survey) on fuel switching was considered in the DEIS and was rejected for use in preference for other, pump observed data. EPA strongly urged the Sobotka study results to be considered in the final EIS. Accordingly, a complete description of the Sobotka study is included. The price sensitive fuel switching-data from self-reported actual behavior of the survey are used in the development of the price sensitive fuel switching rates for the EIS analyses. However, for the reasons described below, we considered the projected behavior data from the trade-off analysis of the Sobotka study unusable in the analysis.

The report consists of results from two surveys. Both surveys are from subsamples of the Market Facts' panel of 65,000 households "broadly representative of the continental United States population who have agreed to participate in mail surveys from time to time." This discussion considers the two surveys, in turn.

Study 1: "Sensitive Question." The first survey was a mailing to 1,000 panel members from which 800 responses were received. Of the 800 returns, 307 reported owning a post-1974 automobile with a catalytic converter.

A "sensitive" question regarding fuel switching was designed so that respondent who owned catalyst equipped vehicles were not forced to reveal whether or not they had misfueled their vehicle; rather, respondents could answer either one of two questions, one of which asked whether the respondent had fuel switched and the other asked an entirely unrelated question. Then, through statistical elimination of the answer to the irrelevant question, analysts estimated that 13.7 percent of the respondents had misfueled two or more times. Ninety percent confidence limits were given as 5.9% and 21.5%.

Study 2: Self-Reported Actual and Projected Behavior. The second survey was designed to investigate misfueling and associated "causes." There were 1500 returned questionnaires of 2600 mailings (57.7% rate of response). Some 1266 of the responses were analyzed, since 234 returns were incomplete or represented households where pick-up trucks, vans, and recreation vehicles were principal means of transport. All 1266 analyzed returns were from households reporting automobiles equipped with catalytic converters. No data has been provided by the survey on statistical confidence limits, but reported proportions should lie within approximately two percent of the true values with 95 percent confidence if the sample is truly representative of the U. S. motoring public.

There were two parts to the second survey. One part was retrospective and reported on past behavior of the respondents with respect to misfueling. Another part of the survey instrument was projective in nature and reported attitudes and preferences with respect to gasoline and services.

Self-Reported Actual Behavior. Respondents were asked to report whether they had previously engaged in fuel switching, and if so how often and at what prices. Other questions were asked which served to substantiate the fact of fuel switching and to seek out possible causes of fuel switching.

The following chart indicates the correlation shown between the difference in price between regular leaded and regular unleaded and the percentage of fuel switching.*

Figure III C-1. Reported fuel switching as a function of price differential.

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* This survey determined whether a respondent was a fuel switcher based upon a set of responses to a series questions, only one of which was the specific question as to whether the respondent had fuel switched. A consistent set of responses categorized a respondent as either a definite switcher or a non-switcher, while conflicting responses labeled a respondent as a probable switcher. These terms are also used in Appendix A.

Unleaded gasoline was rated best by 82 percent of the respondents, while 11 percent rated leaded "best." The study found six percent of respondents who identified themselves as definite switchers. Of that 6 percent, 86 percent rated leaded gasoline "best" and only 7 percent rated unleaded "best."

More non-switchers than switchers indicated problems of knocking and hesitation, while fewer non-switchers reported difficulty with run-on (dieseling) and rough idling. No appreciable differences between switchers and non-switchers were reported with respect to stalling, hard starting, or lack of pep.

The respondents were also asked whether they had ever driven into a station which did not have available the grade of gasoline they wanted to purchase. The results were as follows:

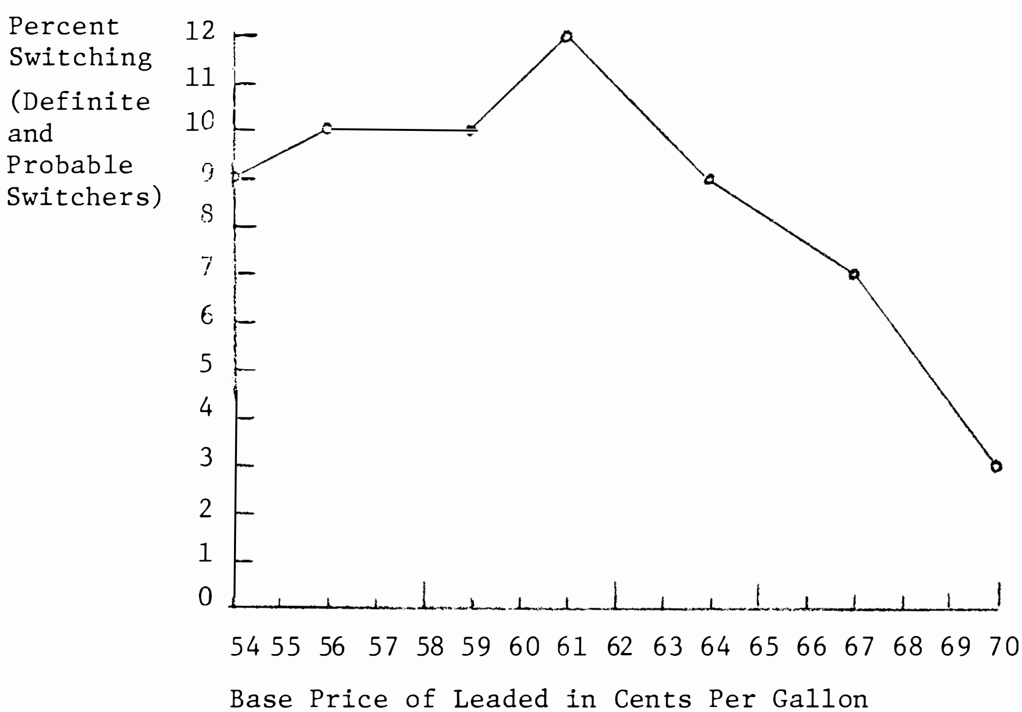
	Percent of Respondents Reporting - Grade and Type		
Grade and Type	Not Available (percent)	Available (percent)	No Answer (percent)
Regular unleaded	6	82	12
Premium unleaded	39	32	29
Regular leaded	3	77	20
Premium leaded	14	57	29

Two primary observations are suggested by the above table. First, the proportion of respondents who indicated regular unleaded to be unavailable is exactly equal to the proportion who identified themselves as definite switchers. It should also be noted that the study reported more switching in rural than in urban areas. This might be attributable to the fact that rural outlets are more likely to be low volume stations not required to handle unleaded gasoline, therefore resulting in unavailability.

Second, 32 percent reported premium unleaded to be available, with another 29 percent giving no response. Since premium unleaded gasoline was sold only by a few major oil companies at the time the survey was conducted and was generally unavailable, these responses, or lack thereof, indicate that some 61 percent of the respondents may have been confused about either the nature of the question, the availability of the grade of gasoline, or both. Taking these two factors into account it is difficult to conclude, as does the study report, that "one may safely rule out unavailability as a significant factor in fuel switching except, possibly, for some occasional purchases in emergency situations."

The study reports the mean perceived price of leaded regular gasoline to be 60.6 cents per gallon for definite and probable switchers and 60.5 cents per gallon for non-switchers, an insignificant difference. Also, there is somewhat of a negative relationship between perceived base price of leaded regular and switching (see chart) with higher rates of switching at lower base prices.

The following chart indicates correspondence between the leaded regular price and percent switching. Fuel switching appears to decrease as regular leaded gasoline prices increase.



Switchers reported an average fuel efficiency of 2.1 miles per gallon of gasoline higher than that reported by non-switchers. The report indicates the better mileage may be as much a function of auto type and driving habits as of the type of gasoline used.

Projected Behavior Through Trade-Off Analysis. A market analysis technique known as "trade-off analysis," involving respondent choices between pairs of products was utilized in order to obtain preferences of respondents with respect to (1) type and grade of gasoline, (2) price, (3) self-service vs. attendant service, and (4) method of payment (cash and/or credit card).

The method has been devised to project possible market share for consumer products, all other things being equal. The technique is useful to a firm when introducting new products. Estimates of potential market share can be made, given, for example, different product design, packaging, marketing and pricing combinations.

The trade-off analysis data was collected by offering the respondents a choice between hypothetical purchase opportunities. The following is a sample from the survey of the type of question asked:

Questions from the Questionnaire

The following pairings are alike in all respects except for the two factors below:

GRADE AND TYPE OF GAS

&

PRICE

Please circle either "L" or "R" to indicate your preference for the pairs below.

Intermediate Unleaded Gas & You Pay 8¢ Above The Base Price	L OR R	Premium Leaded Gas & You Pay 6¢ Above The Base Price
You Pay 6¢ Above The Base Price & Premium Unleaded Gas	L OR R	You Pay 8¢ Above The Base Price & Premium Leaded Gas

The trade-off analysis resulted in the following set of preferences, all other things being equal.

Unleaded Price Differential (cpg above base)	Percent Choosing Leaded
0¢	6
2¢	11
4¢	15
6¢	31
8¢	69

When there was no difference in price between unleaded and leaded, 6 percent preferred leaded. But when there was 8 cent differential, 69 percent preferred leaded.

Critique of the Sobotka Study Trade-Off Analysis. The differences between the trade-off study as conducted and the marketplace functions are several. First, it is not clear from one study that respondents were fully aware of the disadvantages or inconveniences of fuel switching that might offset the price benefit described in the trade-off questions. To be sure the respondents were told "to use unleaded gasoline in your car might require changes in the tank opening to accommodate the wider nozzle used at pumps that have leaded gas." However, this caution was applied to a question in the "reported behavior" section of the questionnaire, which preceded the trade-off questions. In addition,

(1) There was no reminder to respondents that the choices were for their vehicle requiring unleaded gasoline.

(2) There was no warning about poisoning of the catalytic converter.

(3) Nothing was said about mechanical malfunctioning of pollution control devices other than the converter.

(4) There was no hint of possible adverse environmental consequences.

(5) Nothing was indicated about the legality of misfueling.

Gasoline is a standardized product with little variation within grade across brands. This being so, with all other things being equal, one would expect most people most of the time to opt for the best price. One would expect consumers to select the mechanically acceptable grade of gasoline at the lowest price. Given that basic behavior, then trade-offs as to other amenities must be made. Thus, there is a price at which consumers give up some convenience for self-service; where paying with a credit card gives way to paying by cash; etc. Since, within grade and type, the various services are add-on amenities, then it may be assumed that price is the overriding criterion in gasoline consumption behavior. And price is inexorably tied to grade and type of gasoline.

The straightforward interpretation of the results of the trade-off analysis is that 6 percent of the consumer panel expressed a preference for leaded over unleaded at zero cents per gallon price differential; 69 percent expressed a preference for leaded at 8 cents differential, all other things being equal. In market analysis terms, a potential 69 percent share of the market could be induced to purchase leaded gasoline with a massive advertising, marketing and distribution effort to sell them on those attributes found to be so attractive to the sample panel. It is unlikely that such a campaign will occur, however, and it is therefore not likely that the potential candidates for fuel switching identified in the survey will in fact switch.

This is demonstrated by the data from the same panel of respondents on actual purchasing behavior in the marketplace. At 0-2 cents difference 4 percent identified themselves as having switched, and at 8 cents or more difference 8 percent had switched. Figure III C-3 overlays the actual percent switching at given price differentials and the proportion indicating in the trade-off analysis that they might switch at varying price differences, all other things being equal. The extreme differences between actual behavior and expressed preferences could be due to a number of factors, including the tendency on the part of most people to support

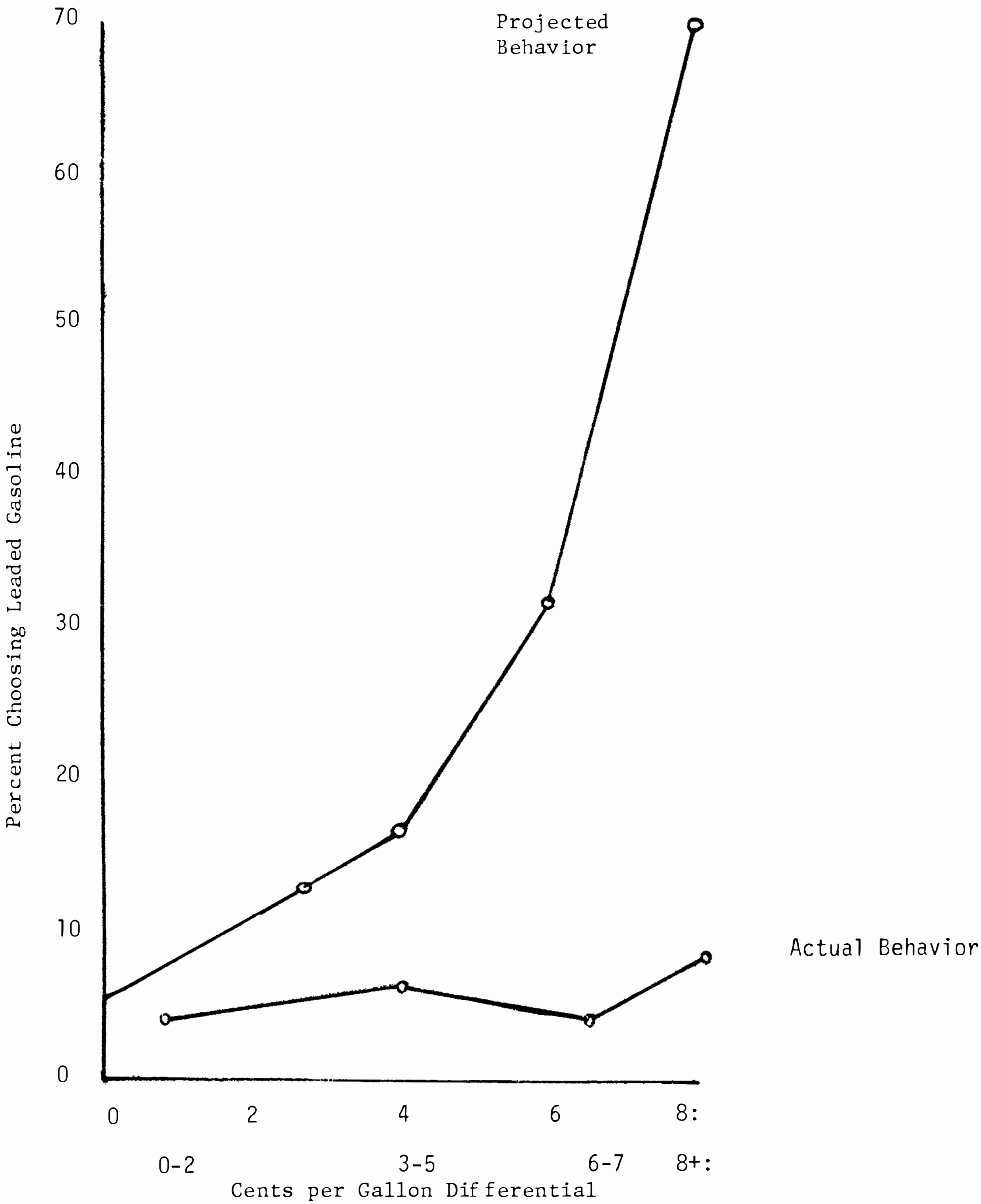


FIGURE III C-2. Projected and Actual Fuel Switching Behavior As Reported by the Same Respondents in the Sobotka Study rules and regulations promulgated by duly designated authorities, even if to do so is costly, and the fact that the respondents did not have to contend with the inconveniences of switching at the time they answered the questionnaire.

Since the actual behavior and the trade-off analysis data are at such variance, it is doubtful that the trade-off analysis technique is an appropriate means of estimating consumer behavior in the purchase of gasoline. One of the commenters (Amoco) pointed out, we believe correctly, that the trade-off analysis technique is not appropriate for products such as gasoline that are standardized, purchased through routine and impulse behavior, and considered by many as a necessity.

For the foregoing reasons, we believe it cannot be concluded there will be a significant increase in misfueling of the type indicated in the projected behavior portion of the Sobotka study if the price differential shifts from, say, 4 cents per gallon to 8 cents per gallon, and we have therefore decided it would be inappropriate in this EIS to use it as the basis of projecting fuel switching rates.

The Amoco Survey

Standard Oil Company of Indiana (Amoco) submitted, along with its oral and written comments a summary of its findings to date from its ongoing survey of consumer gasoline purchase behavior. This survey was conducted by asking a sample of motorists to keep a diary of their fuel purchases over time. The findings were released to the Department of Energy under the cover of confidentiality, due to promises Amoco made to its sources of information. We have consulted with Amoco with regard to the methodology and results of the survey but, because of the confidentiality restriction, we have not been able to subject the Amoco results to the same scrutiny afforded the EPA and GM surveys.

As the Amoco data did not present fuel switching data related to price, and as much of the data is preliminary in nature and covered by Amoco's request for confidentiality, the data were not used in the EIS impact analyses. There were, however, general qualitative observations which proved to be of value in support of the development of the impact analysis methodology. These observations, noted below, are presented with the permission of Amoco:

1) The Amoco study found that, among owners of unleaded vehicles, approximately 5 percent of fuel purchases were of leaded gasoline. However, more than 5% of unleaded vehicles had switched at least twice.

2) The survey showed that fuel switching was far less in GM cars than in other American cars, demonstrating that the GM survey results for fuel switching rates are biased lower than the general vehicle population rates as we suspected in the DEIS might be the case.

3) The survey showed about half of all fuel switchers (in a 4-month interval) had switched only one time.

4) The study showed a significant correlation between fuel switching rate and octane requirement (octane requirements were determined from the engine description, as increased by vehicle age).

III C-3b EPA and GMC Studies in Detail. Unfortunately, for many of the studies cited, there is insufficient information to use in a quantitative analysis or the methodology is suspect. The two studies which do contain enough information on the factors of interest and which are, therefore, extensively used in this analysis are the EPA's "Fuel Switching Analysis" (III-6) and General Motors Corporation's "Fuel Usage Survey." (III-7) These were chosen primarily because they contain information on fuel price differentials, vehicle age, and the rate of performance switching; because they are the most extensively documented; because they are supported by larger unleaded vehicle data bases than the other studies; and because they, being direct observational surveys, seem likely to give a more realistic picture of fuel switching behavior than questionnaire surveys.

First, the EPA and General Motors' studies will be more fully explained with a few of their results, strengths, and weaknesses. Then the results of the two surveys will be combined in a straightforward manner to explain fuel switching as a function of price differential, vehicle age, and vehicle performance.

As was stated earlier, the Mobile Source Enforcement Division at the EPA has been conducting a series surveys of refueling practices for the past year.[III-6] The results given are based on an October, 1978 compilation of all of the available data which have been verified and entered into EPA's computer system.

The data base consists of 4,951 observed vehicles, of which 987 have been confirmed to be unleaded vehicles, 2,987 have been confirmed as leaded vehicles, and 977 are unconfirmed as to fuel type. These observations were made at both self-service and full-service stations in 37 states. In addition, they were made without the prior knowledge of either the station managers or the motorists involved. For any one vehicle the following were noted:

- The vehicle's estimated make, model, and year (Note: no data summaries containing vehicle age as a parameter were available).
- The vehicle's license plate number
- The type of fuel used for refueling
- The price differential between unleaded regular fuel and leaded regular fuel.

To identify the unleaded vehicles more reliably, the observed license plate number was subsequently checked with the state's Department of Motor Vehicles for a confirmation of the estimated vehicle make, model, and year. When the state's records matched EPA's estimate, the observation was considered to be confirmed, and the vehicle could be identified as requiring either unleaded or leaded fuel. Then the required fuel was simply checked against the fuel which was observed being used for refueling for the confirmed unleaded vehicles to estimate the violation rate.

The results of the EPA Survey are as follows:

- 99 confirmed unleaded vehicles were observed refueling with leaded fuel
- The estimated fuel switching rate (FSR) is therefore

$$FSR = \frac{99}{987} = 10.03\%$$ [III-6]

The 99 observations of fuel switching can be more closely examined as to the grade to which the fuel switch was made and as to the existing price differential between unleaded and leaded fuel. It is assumed that a fuel switch made to leaded premium fuel (usually at a higher cost) indicates a switch made for increased engine performance. One should remember that some motorists who switch to leaded regular fuel may also be switching for increased engine performance. But, by considering the number of switches made to leaded premium fuel, an estimate of the minimum rate of fuel switching for performance reasons may be made. Also, by examining how many fuel switches were made at the various price differentials between unleaded and leaded regular fuel, some indication of a relationship between the price differential and fuel switching rate may be seen. The EPA study indicates the following points:

- Of the 61 observations of fuel switching where the grade of fuel switched to was noted, 10 switches were observed refueling with leaded premium fuel. This implies that at least 16 percent of fuel switching is done for increased engine performance. This is consistent with other testimony given in the DEIS responses.
- 10 switches to leaded premium fuel out of 987 confirmed unleaded vehicle observations implies that the fuel switching rate for performance reasons is at least 1 percent.(III-6)

An examination of the misfueling data of Appendix B shows that data are sparse or absent across much of the range of price differentials, as most observations of fueling are clustered in the 3-5 cent range. Where data are sparse, the actual misfueling rate is likely to be significantly different than observed, and very little confidence can be expressed for the observed data. For example, at 6 of the 13 points along the range of data collected in the EPA survey, displayed at the beginning of Appendix B, the data indicate that a price differential increase of 1 cent results in a decrease in the fuel switching rate, which is contrary to the concept of price-motivated fuel switching and is undoubtedly the result of the unreliably small number of observed refuelings at such price differentials.

Finally, some mention should be made of the apparent strengths and weaknesses of the EPA study. First, two strengths found in this study are the following:

- The sample was taken in many different parts of the U.S. (almost every state). The observations may then give a good representation of the entire unleaded vehicle fleet. This is in contrast to others of the studies mentioned which sampled only a limited number of stations in a limited number of areas.
- The vehicles in the study were observed refueling without the knowledge of either the station managers or the drivers. Therefore, the refueling practices should not have been inhibited.

Concerning problems with the EPA study, only one predominant weakness is found here. There were some problems with correctly identifying a vehicle. Since observations were made at some distance from the vehicles without the knowledge or confirmation of the drivers, the study depended on the best estimate of the observers of the vehicle make, model, and license plate number and on Department of Motor Vehicles records to confirm a vehicle as being leaded or unleaded. Some time lag existed between the refueling observation and the confirmation of the vehicle being either unleaded or leaded as the driver was not questioned. This leads to the concern that some vehicles may have been misclassified. The concern here is that misclassifications could easily inflate (and less likely deflate) the estimated fuel switching rate. A relatively small misclassification rate can result in a rather dramatic change in the estimated fuel switching rate (see Appendix C).

The second study examined extensively in this analysis is General Motors Corporation's "Fuel Usage Survey". Here, vehicles were observed refueling in six large urban areas across the U.S., primarily at self-service stations. The methodology for General Motors' study differs from that of EPA's in two very basic ways. First, observations were taken at a particular service station only after obtaining the permission of the station manager. Also, only General Motors vehicles were included in the study so that the vehicle identification number could be used to classify the vehicles as requiring unleaded fuel or not.

Here, the data base consists of 9,585 observed vehicles, of which 1,208 were late-model (1975-1978) General Motors vehicles requiring unleaded fuel. After a motorist was observed refueling his unleaded vehicle, he was approached and was asked to participate in the study and to supply the following information:

- The vehicle identification number
- The type of fuel used for refueling
- The price differential between unleaded and unleaded regular fuel.

Based on the vehicle identification number the vehicle's make, model, and year were ascertained. Then whether the vehicle was an unleaded or leaded vehicle was established from the make, model, and year.

The basic results of the General Motors Corporation's (GMC) study are the following:

- 24 unleaded vehicles were observed refueling with leaded fuel.
- The estimated fuel switching rate (FSR) implied is

$$FSR = \frac{24}{1208} = 1.99\%$$

As in the EPA study, the observations of fuel switching can be examined as a function of the grade of fuel to which the switch was made and as a function of the price differential between unleaded and leaded regular fuel. The following points are indicated by the GM study:

- Of the 24 observations of fuel switching, 3 motorists were observed switching to leaded premium fuel. This implies that at least 13 percent of fuel switching is done for performance reasons.
- The fact that 3 switches were made to leaded premium fuel out of 1,208 observed unleaded vehicle refuelings implies that the fuel switching rate for performance reasons is at least 0.25%

As in the case of the EPA study, these data indicate no strong relationship between the price differential and the fuel switching rate.

Data are also available from the General Motors study on vehicle ages. The number of unleaded vehicles, the number of fuel switches, and the estimated fuel switching rate observed for different vehicle years are as follows:

Vehicle Year	Unleaded Vehicles Observed	Fuel Switchers Observed	Fuel Switching Rate(%)
1975	250	13	5.20
1976	343	7	2.04
1977	404	3	0.74
1978	205	1	0.49

The data seem to indicate a strong positive relationship between vehicle age and the fuel switching rate. That is, the older a vehicle is, the more likely it seems to be that the owner of the vehicle will switch fuels. This relationship is indicated by the way in which the estimated probability distributions for the fuel switching rate shift according to the various years (See Appendix B).

Two important strengths of the General Motors study are the following:

- By using the vehicle identification number to deduce a vehicle's make, model, and year, the vehicle's fuel requirements were probably reliably determined. This means that there should have been fewer problems with vehicle misclassification than with the previously discussed EPA study.
- More extensive information on concomitant variables such as vehicle age, vehicle odometer reading, and sex of the driver was taken. This makes it possible to control for these other variables and to discern more easily any true relationships which might otherwise have been masked.

There are also some weaknesses in the General Motors study. These are the following:

- Current laws governing fuel switching impose fines on service station managers who allow fuel switching to be done at their stations. General Motors obtained a station manager's permission before making observations at his station. They were refused permission at some stations. This suggests that perhaps the study was done at stations with relatively lower fuel switching rates. Of course, if this were true, any estimates of the true fuel switching rate would be biased below the true value. It should be noted, however, that the observations were made primarily at self-serve stations, where the dealer plays less of a role in refueling and there is greater opportunity for misfueling, which would tend to bias the results in the opposite direction. The drivers were also asked, after the fact, to participate. Misfueling drivers are more likely to have refused.

- The study included only General Motors vehicles. There is reason to believe, from the Amoco survey, however, that the misfueling rate for GM vehicles is less than that for vehicles of other manufacturers. Therefore, estimates based on only General Motors vehicles are biased downward.

The results of the General Motors study differ rather significantly from those of the EPA study. There are many possible reasons for this difference, three of which are the following:

- General Motors surveyed only service stations and motorists who gave their permission to be included, while EPA took observations unknown to the service station managers or the motorists. This may bias General Motors estimates of fuel-switching rates on the low side.

- The EPA may have encountered some misclassification errors that, because of the small numbers of vehicles misfueling are likely to inflate that number.
- General Motors had no observations from stations where a price differential of more than 8 cents per gallon between unleaded and leaded regular fuel existed. If there is some positive relationship between the fuel switching rate and the price differential then the GM survey would be expected to yield lower estimates of the true fuel switching rate than the EPA survey.

Both the EPA and GM surveys have been examined in detail, and present quite different images of the perception of the fuel switching problem. In the DEIS, an attempt was made to build composite fuel switching rates as a function of vehicle age and price by the use of formal statistical techniques.

Comments received on the DEIS convinced us that the GM survey data for fuel switching rates were unrepresentative of the general population, and thus the resultant fuel switching rates presented in the Draft EIS, in the expected case, were too low. Comments indicating confusion about the statistical technique used, and about age effects, led us to adopt a simpler, but equally valid, approach for the final EIS.*

In this simpler approach, the incremental fuel switching rates motivated by price differential are explicitly developed. This price-motivated fuel switching is over and above a base rate of fuel switching, which may be

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* The EPA in its comments on the DEIS suggested using the trade-off analysis of the Sobotka Survey as prior probabilities in the Bayesian analysis utilized in Appendix A of the DEIS. However, prior probabilities are a measure of probabilistic belief, not just a statement of trend. We believe, and EPA apparently concurs, that the trade-off data are indicative of a trend but that the absolute percentages overstate probable future behavior. Thus, the condition for using these data as prior probabilities is violated.

motivated by performance, lack of availability, or other non-price related factors. This base rate of fuel switching presumably remains constant among alternatives** considered in this EIS, and, although it is important in the estimation of anticipated total vehicular emissions for the various alternatives, it does not affect the calculation of incremental emissions impacts induced by price-motivated fuel switching.

Appendix A contains details on the derivation of the price-motivated fuel switching. The best, expected and worst case incremental fuel switching rates, are presented in Table III C-1. The best and worst cases bracket the price-motivated fuel switching rates which are derived from all of the known studies which have attempted to examine the relationship of price to fuel switching.

In the DIES we also suggested that the misfueling rate is sensitive to vehicle age. Available data from the GM survey confirms that this is so for the switching that is part of the base case. But there is no data to support a conclusion that incremental, price-motivated switching resulting from adoptions of any of the policy alternatives considered here is also related to vehicle age. Therefore, vehicle age is not a factor used in the present analysis.

III C-4 Direct and Indirect Consumer Costs

The Federal Energy Administration estimated(II-1) the impact on the national economy of a hypothetical per-gallon increase in the price of gasoline by first developing a "base case" for the economy, and then using the same methodology to develop a "test case" which included the price increase. The impact of the per-gallon price increase is the difference between the base case and the test case. The FEA developed two base cases and corresponding test cases. The per-gallon price increases in the test cases were $.01 and $.07 with respect to their base cases. In the $.01 case the economic impact was small as were the direct and indirect costs to the

** To be sure, octane shaving and supply shortages will cause increased fuel switching, as discussed in Chapter IV. The purpose here is to determine the price sensitivity.

TABLE III C-1. INCREMENTAL FUEL SWITCHING RATES (PERCENT) OVER AND ABOVE NON-PRICE MOTIVATED FUEL SWITCHING

	Price Differential			
	1-3¢	4-6¢	7-9¢	10¢+
Best Case	.04	.10	.16	
Expected Case	.95	2.38	3.80	6.5
Worst Case	1.96	4.90	7.84	

TABLE III C-2. SAMPLE CALCULATION OF EMISSIONS. WORST CASE, 4-6 CENTS DIFFERENTIAL

Model Year	Billion Vehicle Miles (a)	HC Emissions grams/mile (b)	Poisoned Catalyst HC Emissions (c)	Prob. of Poisoned Catalyst (d)	Average Emissions Factor	Emissions thousand Metric Tons
1980	133.9	.27	7.63	.0490	.631	84.5
1979	149.4	1.58	7.85	.0490	1.887	281.9
1978	142.9	1.92	8.06	.0490	2.221	317.4
1977	135.2	2.24	8.25	.0490	2.535	342.7
1976	116.7	2.53	8.44	.0490	2.820	329.1
1975	86.9	2.81	8.68	.0490	3.098	269.2
1974	82.0	6.88				564.2
1973	89.0	7.42				660.4
1972	67.9	7.90				536.4
1971	48.6	8.34				405.3
1970	28.7	8.73				250.6
1969	22.5	9.09				204.5
1968	17.5	9.43				165.0
1967	9.9	12.47				123.5
1966	7.8	12.80				99.8
1965	6.7	13.12				87.9
1964	3.3	13.41				44.25
1963	1.9	13.7				26.0
1962	1.3	13.97				18.2
1961	1.4	14.22				19.9
						4948.9

(a) From Table III A-1.
(b) Table III A-2.
(c) Table III A-3.
(d) Table IV A-1, using worst case and 4-6¢ price differential.

consumer. In the $.07 case the economic impact was noticeable in that unemployment levels and income levels were among variables affected. Also in the $.07 case, direct and indirect costs to the consumers were increased significantly (see Chapter IV, Section F).

III D The Environmental Profile

This section discusses the current status of national emissions, regional air quality, and major sources of impacts under the various alternatives.

III D-1 Emissions and Concentrations in General

Nationally, in 1975, there were the following total anthropogenic (man-caused) emissions of air pollutants (in millions of metric tons/year):

Pollutant	Total Anthropogenic	Total Vehicular	% Vehicular
Particulates	16.4	1.7	7.2
Sulfur oxides	29.9	1.8	2.4
Nitrogen oxides	22.0	7.2	44.2
Hydrocarbons	28.1	10.7	37.9
Carbon monoxide	87.5	70.4	80.5

In order to relate the impacts of the alternatives considered to the problems of major cities in improving their air quality, we selected these representative target areas, Washington, D.C., Denver, and Los Angeles (see Appendix D) for analysis. These cities were chosen because each presently exceeds the CO and oxidant National Ambient Air Quality Standards (NAAQS) a significant number of days in each year, each is projecting meeting the NAAQS in the future, as the vehicle fleet becomes progressively cleaner, their problems in meeting the NAAQS are largely mobile source related, and they generally reflect the air quality problems of most major cities. Ambient air quality and attainment data for these cities are shown below:

City	Pollutant	1976 Concentration*	NAAQS Attainment
Washington, D.C.	CO	15.5 ppm	1987
	Oxidant	.225 ppm	1987
Denver, CO	CO	23.4 ppm	1987
	Oxidant	.171 ppm	1987
Los Angeles	CO	30.0 ppm	1987
	Oxidant	.51 ppm	1987

III D-2 Refinery Emissions

The possible environmental impacts associated with the manufacture of unleaded gasoline are primarily related to the operation of the catalytic reformer. Although there are few pollutants associated with this process, there are emissions associated with the process heat needed to operate the reformer and the atmospheric distillation unit.

Increased air pollutants resulting from the use of catalytic reformers will include additional amounts of particulates, sulfur oxides, hydrocarbons, nitrogen oxides, and aldehydes. No significant additional land requirements and no additional water pollutants are anticipated to result from increased catalytic reformer output.

The pollutant load from direct boilers and process heaters has been estimated by EPA.[(III-13)] The emission factors for petroleum refineries were increased to reflect an increase of 0.0534 barrels of crude per barrel of reformer output.** Resultant pollutant loadings were calculated as follows:

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*EPA critiqued these numbers on the ground that they are incompatible with recent EPA compilations. The local agencies were once again called (January 15, 1979) and they provided these data, which are now being used in the final stages of SIP revisions mandated by the 1977 Clean Air Act.

**Assuming
- o 0.374×10^{12} Btu/year direct process heat required for catalytic reforming[(III-13)]
- o 1.25×10^{9} Bbl/yr crude oil processed[(III-14)]
- o Yield of reformate of approximately 80 percent[(III-15)]
- o 5.6×10^{6} Btu/bbl crude oil

Particulates	0.0561 lb/bbl reformate
Sulfur oxides (maximum)*	0.449 lb/bbl reformate
Hydrocarbons	0.00935 lb/bbl reformate
Nitrogen oxides	0.194 lb/bbl reformate
Aldehydes	0.00167 lb/bbl reformate

These values represent the lower end of a range of possible additional pollutant loadings which may result from refineries producing increased amounts of unleaded gasoline.

These estimates may be increased to reflect higher pollutant loadings where additional distillation to produce extra feedstock is taken into account. It has been estimated that 0.00312 bbl of additional distillation fuel would be needed for each barrel of reformate.** This factor was applied to EPA's estimated emission factors for boilers and process heaters in petroleum refineries. The product was added to the pollutant loadings calculated for the additional process heat required for the reforming process. These emissions, therefore, are predicted to result from the incremental process heat needed to run the catalytic reformer and an atmospheric distillation unit to produce extra feed:

Particulates	0.0587 lb/bbl reformate
Sulfur oxides(maximum)***	0.470 lb/bbl reformate
Hydrocarbons	0.00979 lb/bbl reformate
Nitrogen oxides	0.203 lb/bbl reformate
Aldehydes	0.00175 lb/bbl reformate

*Fuel oil sulfur content (weight percent): factors based on 100 percent combustion sulfur to SO_2 and assumed density of 336 lb/bbl (0.96 kg/liter). Assumes gases produced by processing crude are not desulfurized before burning.

** Assuming
- o 0.380 x 10^{12} Btu/yr process heat required for atmospheric distillation(III-14)
- o 5.44 x 10^9 bbl/yr crude oil processed(III-14)
- o Yield of reformate is approximately 80 percent(III-15)
- o 5.6 x 10^6 Btu/bbl crude oil

***Assumes no fuel gas desulfurization in the refinery.

III E The Regulatory Environment

III E-1 DOE Gasoline Regulations

The Department of Energy regulations regarding the pricing and allocation of gasoline have been described previously. The enforcement of these regulations as applied to refiners, especially as to prior violations, is vigorous. The Office of the Special Counsel for Enforcement was established by DOE to provide thorough auditing of the 34 largest refiners, and this office has completed or pending enforcement cases against these firms totaling several billion dollars in potential refunds. A significant percentage of this amount involved potential overcharges in the prices charged for gasoline. The ERA's Office of Enforcement is also pursuing a vigorous enforcement program with regard to refiners other than the 34 largest.

Enforcement of DOE price regulations applicable to retail dealers has been less thorough, particularly since 1975. This has been due to a determination made by the Federal Energy Administration and DOE, and implicitly concurred in by Congress through its appropriations for the enforcement program, that enforcement efforts aimed at other segments of the petroleum industry are far more cost effective. Survey data obtained by the EIA from retail dealers prior to July 1978 suggest but do not confirm that most retail dealers were selling all grade of gasoline from both full-serve and self-serve pumps at less than maximum lawful prices during that period. The same data, plus that collected by other survey organizations, suggest also that some dealers are selling certain grades of gasoline, especially unleaded regular from full service pumps, at or above lawful levels. A survey of 372 high-priced stations was made by ERA's Office of Enforcement in the last half of 1978, and 223(59 percent) were found to be in violation of margin limitations on at least one grade of gasoline. This was not a random survey, however; the surveyed stations were selected because of their high prices and the suspicion that they were among the most likely to be in violation. Because enforcement effort at the retail level has not been thorough due to a re-direction of resources to more cost-effective areas, the true rate of violations is unknown.

In addition to those rules regarding the pricing and allocation of gasoline, another DOE regulation (10 CFR 212.129) states in part that both the maximum permissible retail gasoline price and the octane number or numbers of the gasoline dispensed from the pump must be posted on the face of each pump in legible numbers at least 1/2 inch high. The regulation further provides that dealers may use the octane posting format prescribed by the Federal Trade Commission (FTC) pursuant to its rule 16 CFR 422.1, in lieu of the DOE requirement. (The FTC rule was issued but never made effective due to an adverse court decision.) Willful violators of

regulations governing retail distribution of refined petroleum products are subject to imprisonment of up to one year or fines up to $10,000 or both (15 USC 5754). Recent compliance efforts have indicated widespread non-compliance with the DOE price and octane posting requirements.

The Petroleum Marketing Practices Act, enacted June 19, 1978, requires the FTC to issue octane posting regulations by December 20, 1978, a deadline that has not yet been met. The FTC proposed regulations, issued September 20, 1978 (43 FR 43028, September 22, 1978) would be more comprehensive than the DOE regulations, require larger octane number signs to be posted, and provide for a more uniform octane rating determination using the formula (RON +MON)/2. When the FTC octane posting regulations become effective, ERA intends to delete its own duplicative octane posting requirement.

III E-2 EPA Gasoline Regulations

III E-2a Lead Regulations. According to EPA regulations (40 CFR Part 79), all designated motor vehicle gasolines must be registered and the appropriate information concerning gasoline registration and reporting requirements must be supplied to the EPA. The following definitions with respect to lead apply to motor vehicle gasoline: First, "Unleaded" gasoline contains no more than 0.05 grams of lead per gallon. Second, "Leaded premium" gasoline contains more than 0.05 grams of lead per gallon and is sold as "premium". Third, "Leaded non-premium" gasoline contains more than 0.05 grams of lead per gallon and is not sold as "premium". The EPA has also developed a lead phasedown schedule for refiners which states in part that the average lead content per gallon of gasoline shall not exceed 0.8 grams after January 1, 1978 and 0.5 grams after October 1, 1979. (40 CFR 80.20). Pursuant to the regulations, EPA has granted waivers of the 0.8 grams per gallon standard to refiners that produce approximately 75 percent of the nation's motor gasoline supply.

III E-2b EPA Regulations Applicable to Distributors, Dealers and Consumers. The EPA has several regulations concerning gasoline distributors, retailers, and wholesale purchaser-consumers, i.e., bulk purchasers and consumers of gasoline (such as fleet operators). Examples of regulations affecting distributors are, first, that no distributor may sell gasoline as "unleaded" gasoline unless it meets the definition of unleaded gasoline as stated in 40 CFR 79.32. Second, no carrier of gasoline shall cause unleaded gasoline to fail to comply with the definition of unleaded gasoline at the time of delivery (40 CFR 80.21).

The following controls apply to gasoline retailers: First, no retailer may sell gasoline as unleaded unless it meets the appropriate definition, nor may it introduce leaded gasoline into a car to which the warning "unleaded gasoline only" is affixed or in which the car filler inlet is designed to accept the unleaded gasoline nozzle only. Second, retail gasoline outlets must offer unleaded gasoline of not less than 91 research octane number (RON) for sale either if the outlet sold over 200,000 gallons of gasoline during any calendar year starting with 1971, or if the outlet sold over 150,000 gallons during any calendar year starting with 1971 and if the outlet was located in a county having a population density of under 50 people per square mile (40 CFR 80.22).

Wholesale purchaser-consumers of gasoline are prohibited from introducing any gasoline other than that meeting the definition of unleaded into any vehicle marked with "unleaded gasoline only" or having a restricted filler inlet.

Violations of the regulations of 40 CFR Part 80 carry a penalty of $10,000 per day. As of November 1978, EPA had 23 regional personnel assigned to the enforcement of these regulations. As of the same date, 47 cases had been brought by EPA, for improper introduction of unleaded gasoline 28 against retail dealers and 19 against fleet operators. Of the total number, 28 cases have been completed, with an average penalty imposed in each of $2,500. EPA has stated that its enforcement of these regulations has been severely limited by the lack of necessary resources.

It should be noted that EPA requires only that unleaded gas of 91 RON be made available. Actual RON of unleaded gasoline at the pump is currently averaging 92.9 (1977). Many post-1974 cars need 92.5 or higher. Of greater significance in engine behavior is (RON + motor octane number (MON))/2; this is the value posted on gasoline pumps. Most unleaded gasoline is 1 number lower than regular in this measure of octane.

III E-3 EPA Emissions Regulations and Enforcement

EPA's responsibility to determine national environmental goals for air quality has resulted in promulgation of National Ambient Air Quality Standards for the following categories of air pollutants:

- o Total suspended particulates
- o Sulfur dioxide
- o Nitrogen oxides
- o Carbon monoxide
- o Photochemical oxidants
- o Hydrocarbons
- o Lead.

States and local governments specify emission limits for these pollutant categories by types of polluters often as part of State Implementation Plans (SIP's), while new motor vehicle emissions and selected stationary sources are regulated by the EPA. Of the pollutants listed above, only hydrocarbons, carbon monoxide, and oxides of nitrogen are applicable to motor vehicle emission standards. Current emissions standards issued and enforced by EPA are presented in Table III A-2. These emission standards are presented by type of vehicle, model year, and regulated pollutant.

Certification and testing of each manufacturers' full line of vehicle engines for compliance with mobile sources standards is accomplished each year. In addition to this certification process, monitoring of vehicles in actual consumer use is carried out by the EPA each year for a representative sample of in-use vehicles. Enforcement of the mobile source standards may entail any or all of the following actions:

- o Inspection and investigation of foreign and domestic manufacturers' certification and production activities to prevent introduction of uncertified new domestic and imported vehicles;
- o Conducting vehicle assembly line emission testing;
- o Enforcing the recall, warranty, and tampering provisions of the Clean Air Act; and
- o Ensuring implementation and compliance with vapor recovery requirements, inspection/maintenance requirements, and vehicle miles traveled requirements of Transportation Control Plans.

If EPA finds, through its initial assembly line checks, its Selective Enforcement Audit (SEA) program, or through the state inspection/monitoring programs, that a particular vehicle model, line, or engine type does not conform to emission standards, the production of that model, line, or type may be halted, or vehicles may be recalled to have faulty systems repaired or replaced. Eleven recalls have occurred to date, each initiated by the manufacturer rather than by a Federally imposed recall program resulting from processing a case all the way through the legal system.

III E-4 State/Local Regulations and Enforcement

Under the Clean Air Act, states and local governments retain primary responsibility for prevention and control of air pollution. Therefore, while the Federal EPA regulates the vehicle exhaust emissions applicable to the production of new motor vehicles and engines, the states, through SIP's, are encouraged to conduct inspection/maintenance programs to determine the effectiveness of emission control systems on in-use vehicles. States which have recently included these programs in their SIP's perform an inspection/maintenance either prior to issuing a vehicle registration each year or, in some cases, as voluntary air pollution control measures. States implementing mandatory programs include New Jersey, which pioneered the program more than five years ago, and Rhode Island. Phoenix, Tucson, Cincinnati, Las Vegas, Reno, and Portland, Oregon have mandatory programs, while Chicago has a voluntary program.[III-16] Connecticut, Denver, Pittsburgh, and Philadelphia are to commence inspection/maintenance (I/M) programs in 1980. Los Angeles plans to implement an I/M program in 1979 for cars being resold. All cities which fail to meet auto-related ambient air standards are expected to implement similar programs by 1983.[III-16]

Both the regulatory program and the surveillance program depend on a valid test procedure by which emissions can be measured. The Federal Test Procedure (FTP) measures emissions during three phases of vehicle operation, and can be described as follows.[III-16]

A "cold transient" phase is representative of vehicle start-up after a long engine-off period; "hot-start" vehicle operation occurs after a short engine-off period; and a "stabilized" phase is representative of warmed-up engine operation. The cold, hot, and stabilized phases are 21 percent, 27 percent, and 52 percent, respectively, of the total FTP mileage.

The cold vehicle operation phase is defined as the first 505 seconds of vehicle operation following a long engine-off period at 68^{o} to 86^{o}F. Emissions are collected in bags according to the three phases of operation. Bag 1 represents the emissions sampled under cold start conditions with an average speed of 26 mph; Bag 2 represents emissions sampled under stabilized conditions with an average speed of 16 mph; and Bag 3 represents emissions sampled under hot start conditions with an average speed of 26 mph.

For use in those situations where either the bag-specific average speeds or the percentage of cold, stable, and hot operation do not match the values cited above, correction factors have been published by EPA.

Tests such as the FTP described above, however, are too complex and time-consuming to be administered at the state or local level to in-use vehicles. States and localities therefore use "short tests", which in general fall into two groups: those measuring hydrocarbon and carbon monoxide emissions at idle speeds, and those measuring hydrocarbon, carbon monoxide, and nitrogen oxides emissions at variable speeds using a dynamometer. As the short test introduces a number of uncontrolled variables, the EPA submitted five different fleets of vehicles to the short tests and the more complex FTP to ensure that the short tests results were reasonably capable of being correlated with the FTP results. These were:

- The idle test
- The Federal 3 mode test
- The Clayton key mode test
- The Federal short cycle test
- The New York/New Jersey composite test.

Short test cut-off points will be established on a yearly basis by the EPA for the most recent model year light duty vehicles and light duty trucks beginning with the 1979 model year. These cut-off points will be applicable to the warranty provisions for emissions control systems produced for 1979 and later models. Under the warranty provisions, emission control systems will be repaired by the manufacturer if found to be defective before 5 years or 50,000 miles, as determined by EPA approved short tests. For these tests to be valid and approved by EPA for the warranty provision, false positive results (where the short test incorrectly predicts failure for a vehicle that really satisfies the FTP) must occur less than 5 percent of the time. By varying the stringency of the cut off point values, it is possible to reduce false positive results to any desired level, but at the cost of increasing false negative results. It is therefore possible for some vehicles passing EPA approved short tests to fall below passing standards of the more controlled Federal testing program.

III F The Economic Profile

III F-1 Refiners

The Emergency Petroleum Allocation Act defined three types of refiners, based on refining capacity and crude oil self-sufficiency. The fifteen "major" refiners* have refining capacities in excess of 175,000 B/D

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* Amoco, Atlantic-Richfield, Chevron, Cities Service, Continental, Exxon, Getty, Gulf, Marathon, Mobil, Phillips, Shell, Sun, Texaco, and Union.

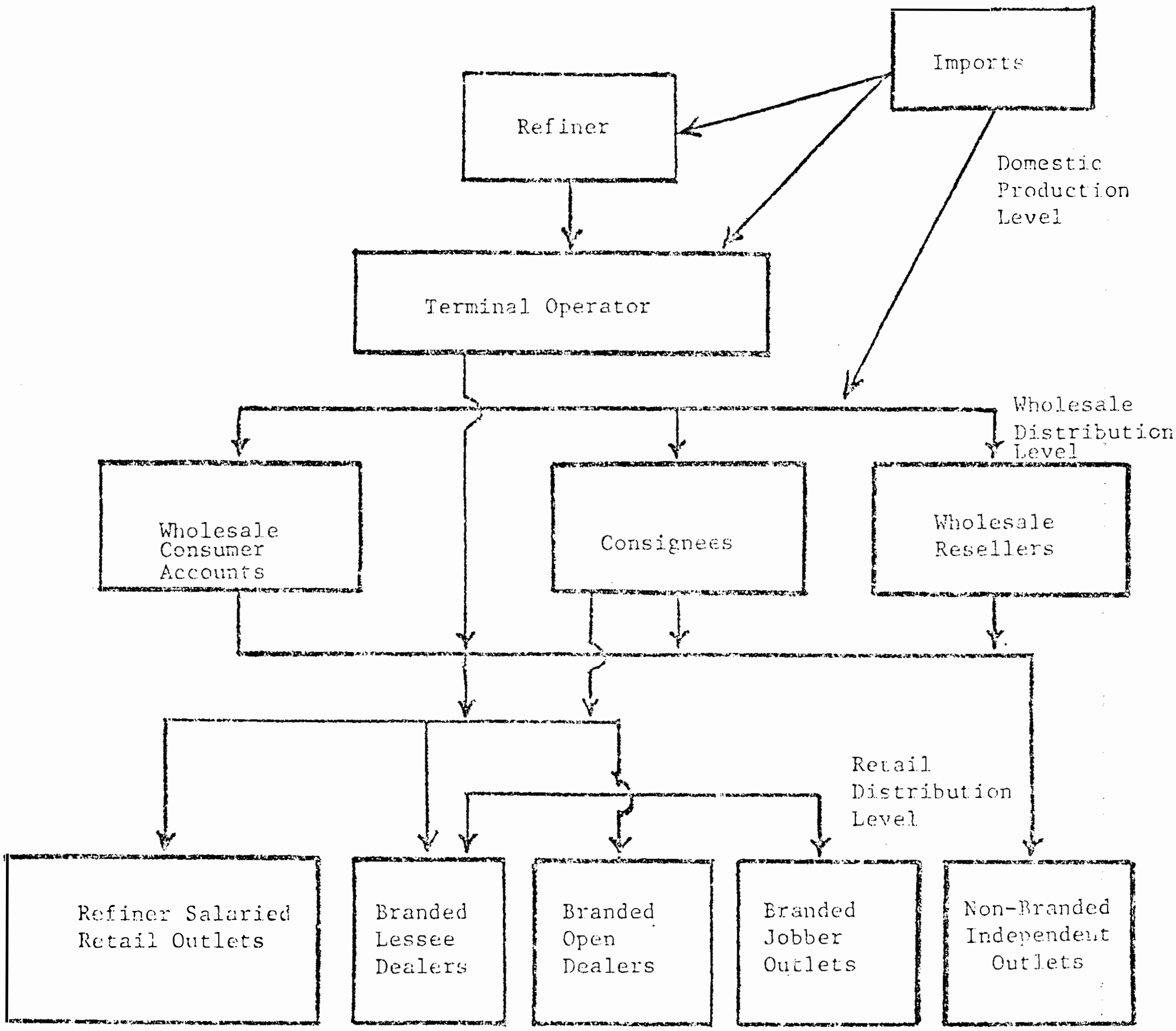
TABLE III-F-1. TOTAL GASOLINE SALES (IN BILLIONS OF GALLONS) AND REFINER CATEGORY SHARE OF DISTRIBUTION

REFINER TOTALS	1972	1976	CHANGE
TOTAL REFINER SALES	100.6 gals	111.4 gals	+10.7%
LARGE INTEGRATED (MAJOR)			
SALES	74.0 gals	79.1 gals	+ 6.9%
SHARES	73.6%	71.0%	- 2.6 pts*
LARGE INDEPENDENT REFINERS			
SALES	8.3 gals	8.9 gals	+ 7.2%
SHARES	8.3%	8.0%	- 0.3 pt.*
SMALL REFINERS			
SALES	18.2 gals	23.3 gals	+28.0%
SHARES	18.1%	20.9%	+ 2.8 pts*

* Percentage point increase or decrease

Source: FEA Forms P-305-S-0 and FEA P-306-M-0

FIGURE III-F-1. MOTOR GASOLINE DISTRIBUTION



and own or control directly more than 30 percent of the amount of crude oil processed in their refineries.(III-17) The "large independent" refiners** have refining capacities in excess of 175,000 B/D but own or control less than 30 percent of the amount of crude oil used in their refineries. Approximately 140 "small" refiners have refining capacities of less than 175,000 B/D. Most but not all small refiners also own or control less than 30 percent of the crude oil used in their refineries.(III-17)

Table III F-1 shows total gasoline sales and distribution of sales by refiner category for 1972 and 1976. The table shows that small refiners' share of the market has increased 2.8 percentage points, while large major refiners' sales have declined by 2.6 percentage points. Almost all of the motor gasoline consumed in the United States is produced in domestic refineries; less than 3 percent is imported.(III-17)

Gasoline is distributed through a complex network of refiners, wholesalers, and retailers depicted in Figure III F-1. Refiners distribute gasoline to the following:

- Terminal operators
- Branded and nonbranded jobbers
- Consignees and commission agents
- Large-volume retail consumers (for example, truck fleets, automobile rental firms and other industry accounts)
- Refiner salaried retail outlets, including secondary brands

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** Amerada-Hess, American Petrofina, Ashland, and Sohio. Since enactment of the EPAA in December 1973, Coastal States, Kerr-McGee and Tosco have also reached this category and Sohio has moved into the major refiner category by virtue of its becoming a major producer of crude oil through exchange of stock for British Petroleum's holdings on the North Slope of Alaska. For consistency of analysis, market share data include only the original four as large independent refiners.

- Branded retail dealers, both open (that is., dealers who own or lease outlets from parties other than their suppliers) and lessee dealers (that is, dealers who lease outlets from their suppliers)
- Large independent marketers who usually sell their own brand through salaried retail outlets.(III-17)

Total refiner gasoline sales in 1976 by category are shown in Table III F-2. The distribution pattern differs appreciably among the refiner categories. Direct sales by major refiners amount to 8.5 percent of their total sales, compared with 3.4 percent of the large independent refiners' total and only 1.1 percent of the small refiners' total. On the other hand, sales at salaried retail outlets by major refiners are only 7 percent of their total, compared with 25.8 percent for large independent refiners and 23.1 percent for small refiners.

Distribution of sales to the different classes of independent marketers also differs appreciably. Almost three-fourths of such sales by major refiners are as branded products to lessee dealers and jobbers, compared with about 50 percent by large independent refiners and 30 percent by small refiners. Conversely, 60 percent of the outside sales by small refineries are as nonbranded products to jobbers, compared with 50 percent by large independent refiners and only 12 percent by major refiners.

III F-2 Distributors (Wholesale-Resellers)

The category of wholesale-resellers includes independent wholesalers, terminal operators, consignees, and brokers, as well as traditional branded and unbranded jobbers.

Wholesale-resellers store and distribute gasoline to retail outlets. These outlets may be either branded or nonbranded lessee dealers, open dealers, or dealers who lease outlets from wholesale-resellers. A wholesale-reseller may also make direct sales to bulk consumers, such as farm, commercial or industrial accounts. Some wholesale-resellers also own outlets that are operated by salaried employees. A consignee sells and delivers petroleum products at the wholesale level but this method of operation differs from that of most wholesale-resellers in that (a) for the most part, remuneration is on a commission basis, and (b) title to the product remains with the refiner and the refiner's invoice is used in the billing of the product. Under the normal arrangements in effect for consignees, sales can be made to branded retailers or directly to accounts of commercial and agricultural customers.

TABLE III-F-2. TOTAL REFINER GASOLINE SALE BY CATEGORY, 1976
(Thousands of Gallons)

	1976	Large Integrated (Major) Refiners			Large Independent Refiners			Small Refiners		
		%	%	Gal.	%	%	Gal.	%	%	Gal.
(i)	All methods (total)	100.0		79,139,268	100.0		8,943,442	100.0		23,382,256
(ii)	Direct sales for consumption to bulk purchaser	8.5		6,719,334	3.4		301,853	1.1		255,727
(iii)	Refiner salaried retail outlets	7.0		5,507,970	25.0		2,310,612	23.1		5,402,815
(iv)	Independents, in total	84.6	100.0	66,911,964	70.8	100.0	6,330,977	75.0	100.0	17,723,714
(v) (a)	Branded product to jobbers		31.8	21,299,504		31.8	2,010,351		19.8	3,511,881
(vi)(a)	Nonbranded product to jobbers		11.8	7,908,354		50.0	3,168,300		60.0	10,643,649
(vii)	Branded product to open dealers		14.7	9,809,142		1.4	85,497		9.7	1,715,787
(viii)	Branded product to lessee dealers		41.7	27,894,964		16.9	1,066,829		10.5	1,852,397

(a) This category includes brokers, branded and unbranded jobbers, terminal operators, and independent marketers.

Source: DOE data collected on Form FEA P-306-M-0.

Note: 1) Percentages may not total 100 due to independent rounding.
2) Data may not agree with DOE previously published figures because of revision of preliminary data.
3) Column 2 of each table is a breakdown of sales to independents.

Present DOE regulations require prime suppliers to make an additional assignment of gasoline to a wholesale-reseller whenever a base period allocation for a new retail outlet is approved. Since there is no requirement for a decrease in allocation if the wholesale-reseller supplied retail dealer goes out of business, the wholesale-resellers losing retail outlets have been able to redistribute an increased volume of gasoline among their customers and also among their own retail outlets. The branded independent dealers allege that this redistribution of gasoline by the wholesale-resellers places them in an unfair competitive position when competing at the retail level. This "upward certification" provision of the regulations may have created some market share distortions.

Since the DOE does not collect complete data on wholesale-resellers, it has no definitive information on the total number of wholesale-resellers or the number of stations or other customers those wholesale-resellers supply. Industry sources estimate that wholesale-resellers number between 12,000 and 18,000, and that most of them own or control, through leases or supply agreements, several retail outlets.(III-18)

Sales by major refiners to wholesale-resellers amounted to 29 billion gallons in 1976, an increase of 40 percent over 1972. The large independent and small refiners supplied 19 billion gallons to this class in 1976, an increase of 30 percent over 1972.

III F-3 Retail Dealers

This category comprises both lessee dealers, who rent outlets from their refiner or wholesale-reseller suppliers, and "open" dealers who own their outlets or lease them from third parties who are not their suppliers.

The principal types of businesses operated at the retail level include: first, full service outlets; second, gas-and-go outlets (high volume, with limited or self-service); and third, combinations of the two (split island). In addition, many businesses sell gasoline as a sideline to their primary business, such as convenience stores, discount stores, and department stores.

Branded dealers (open and lessee) purchased 37.7 billion gallons of gasoline directly from major refiners in 1976, a decline of 9 percent from 1972. During the same period, sales to branded dealers by large independent refiners declined by 14 percent and similar sales by small refiners declined by 48 percent. Total decline in volume sold to branded dealers by all refiners declined by 11 percent.

This has resulted in a significant decline in the number of branded independent retail outlets. Based on data collected by the Bureau of the Census for DOE, the number of such outlets declined from 178,900 units in November, 1974 to 154,000 units in November, 1976, a decrease of 14 percent.[III-18]

The fact that the percentage decline in volume of sales between 1972 and 1976 is substantially less than the decline in number of outlets between November, 1974 and November, 1976 indicates that average volume of sales per outlet has increased substantially.

III F-4 Salaried Retail Outlets

Major and non-major refiner sales through salaried retail outlets increased 5.4 billion gallons or 69 percent during the period January, 1972 through December, 1976. The large independent and major refiner categories increased sales by 800 million gallons (53 percent) and 2.1 billion gallons (62 percent), respectively. Small refiner salaried retail outlet sales were up 2.5 billion gallons or 86 percent. Salaried retail outlet sales of small refiners, as a percentage of total refiner salaried retail sales, were 37 percent in 1972 and 41 percent in 1976. The major refiner salaried retail outlet sales as a percent of total refiner salaried retail outlet sales, however, declined from 44 percent in 1972 to 42 percent in 1976.

Between 1974 and 1976, the number of salaried retail outlets for the 30 largest refiners, each with a refining capacity greater than 100,000 B/D, increased from 8,945 to 11,352. However, only five of those refiners accounted for approximately 90 percent of the increase during the period, and most of the major refiners decreased their number of salaried retail outlets.[III-18]

III G Major Assumptions and Uncertainties

There are many problems faced in this analysis, since the understanding of the phenomena which may create impacts is not complete. In addition, the future of many affected programs is subject to the political process and hence uncertain.

The approach selected for the EIS is to deal explicitly in the analysis with as much of the existent uncertainty as possible. The remaining cases of uncertainty and assumptions are then presented, and the sensitivity of the results to these items is developed and shown.

III G-1 Uncertainities

The major source of uncertainty not treated in the analysis is that of the actual misfueling behavior. All observational data which have been collected have been for random observations of the vehicle population, not time series observations on a selected subset. Thus the data may reflect habitual behavior or random behavior. In other words, observations could be either or misfueling of vehicles which are continually misfueled or of vehicles that are randomly misfueled.

Since only two consecutive misfuelings may deactivate a catalyst permanently, the actual number of impaired catalysts in the vehicle population will be larger if the behavior is the random case than if it is habitual. For the purpose of impact analysis, the behavior is assumed to be habitual for the same observed misfueling rate. This is consistent with the belief that the decision to misfuel is made prior to pulling up to the pump, especially since misfueling is difficult without prior preparation (such as removing the filler inlet restrictor or carrying a funnel).

Public comments did not provide any definitive data on whether the misfuelers observed at the pump are repeat or random misfuelers. The Amoco survey received in public comments suggested that about half of the misfuelers had done so only once during the four month survey period, and, of the remainder, the majority were frequent misfuelers. To the extent that observed misfuelings are "one-timers", the assumption (as used in the DEIS) that all misfueling is repeat behavior would result in overstating the actual occurence of impaired catalysts in the vehicle population. On the other hand, if a large number of misfuelings are by occasional (more than once but less than habitual) misfuelers, the observed misfueling rate could also be shown to understate the actual number of impaired catalysts.

The purpose of this EIS, however, is not to identify the actual rate of fuel switching in the vehicle population, but rather to determine the rate that would be induced by the adoption of DOE's policy alternatives. For this reason, it is explicitly assumed that the increase in fuel switching observed at higher pump price differentials is done for price purposes, not for performance or other reasons, and the individuals who switch at higher price differentials will repeat this behavior when the same differentials are once again encountered. For the sake of completeness, the EIS also addresses the alternate assumption that price-differential induced switching is a completely random phenomenon.

III G-2 Assumptions

This section lists those specific assumptions which have been made in the impact analysis. After the impact analysis is developed, the sensitivity to each assumption will be examined in Chapter IV, Section E.

III G-2a Vehicle Aging. There exist no data on misfueling behavior of cars older than 3 years, the age of the oldest catalyst equipped vehicles in the current general vehicle population. The scant data which exist for vehicle ages [III-7] show a strong dependency of misfueling behavior on vehicle ages, with a significant change between 2 and 3 year old vehicles, that is, between 3 and 4 years after day of purchase.

It was assumed in the DEIS that vehicles older than 3-4 years are misfueled at the same rate as 3-4 year-old vehicles. This conclusion was based primarily on the fact that, on the average, between 3 and 4 years of age a private passenger vehicle surpasses 50,000 miles, which may be a psychological turning point in the minds of owners, because it may coincide with the public perception of the effective life of the converter.* The rate change also parallels the time of second ownership for much of the vehicle fleet. It was assumed that after the significant increase in fuel switching that occurs between 3 and 4 years, the incidence of switching then flattens.

Comments received on the DEIS, particularly from the Center for Auto Safety, argued that vehicles four years old or more will misfuel at higher rates than three-year-old vehicles. We recognize this possibility. However, for the reasons set forth in section C-3c of this chapter and discussed more fully below, we have determined that the incremental impacts of tilt and deregulation are essentially independent of the assumed misfueling rate for older vehicles.

The DEIS attempted to recognize vehicle age as a cause of fuel switching, in order that the fuel switching caused by age would not erroneously be related to price. However, the available data on fuel switching by age and by price was sparse, and did not support the development of a deterministic model relating to price, age, and fuel switching. Accordingly, the DEIS analysis used statistical techniques to develop the expected fuel switching rate for each price/age combination, as well as the quartile and 1 percent confidence limits. These rates, when used to forecast emissions, showed little sensitivity to the assumption of misfueling rates for older vehicles (the sensitivity was determined by comparing emissions for the rates presented in the DEIS to emissions for rates two and three times higher for 4 and 5 year old vheicles, respectively); the little sensitivity shown was due to statistical aberrations in the source data.

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* EPA regulations for vehicles call for a 50,000 mile survival of the emissions control system, a fact which is reflected in vehicle warranties, with which the owner is likely to be familiar.

Because of the confusion caused by the statistical techniques used in the DEIS, and because of the questions unnecessarily raised about the assumption of age effects for four and five year old vehicles, a simpler approach is taken in this final EIS, wherein the price and age effects are presented separately and independently. Thus, while the assumption of misfueling rates for four and five year old vehicles may still be questioned, it has no effect on misfueling induced by price.

It might be argued that older vehicles might be more prone to misfuel for a given price differential than newer vehicles. However, there are no data which present price-differential induced fueling as a function of vehicle age, and assumptions about this possible tendency (in either direction) would be unjustifiable. Accordingly, the price sensitivity that is determined is applied to the complete vehicle population.

III B-2b Gasoline Shortages. The choice of action to be taken by DOE must recognize the possibility of a real or perceived shortage in the availability of unleaded fuel. The DOE is continuing to perform supply/demand analyses which show if, and how, demand will be met. However, an argument exists that the existence of controls will inhibit the investment necessary to meet demand, particularily in facilities that will be available in 1981 and beyond.

As an assumption, the analysis that follows is undertaken with the belief that the energy industry will strive, in the aggregate, to meet the coming demand. It also assumes that the cross-elasticity of demand for the various grades of leaded and unleaded gasoline will remain relatively constant.

The 1973-1974 shortage provides a case history of price changes which may be used to examine the effects of a perceived shortage. The sensitivity of the impact analysis to a shortage is examined in Chapter IV.

III G-2c Octane Number Requirements. Currently, the octane number of most unleaded gasoline marketed by U.S. refiners is about 87 (R+M)/2, a level which is presumed to satisfy the requirements of most vehicles produced (but does not satisfy all because of the variation among individual vehicles even in the same production line). Unleaded gasoline at retail pumps averages about 1 octane number (RON) higher than the legal minimum of 91 (RON).

As vehicles age, their octane requirements increase somewhat due to buildup of carbon deposits in the combustion chamber which increase the tendency to knock. Also, as the mandated fleet fuel economy becomes more stringent, vehicles engines may have higher compression ratios and thus require a higher octane fuel.

The former condition is addressed directly in the analysis procedure, using the limited data on misfueling as a function of vehicle age. The latter condition is not examined, as the only vehicle years affected would be the 1980-1981 models, which by 1980 would be 0-1 years old, and thus should have minor performance-induced misfueling rates. In addition, as pointed out in many comments, there is a growing trend among refiners to market a higher-octane unleaded grade of gasoline (91 (R+M)/2) in order to satisfy those customers experiencing performance problems with 87 octane unleaded. The increased availability of unleaded premium gasoline should tend to offset performance-induced misfueling that would result from higher compression engines.

III G-2d Octane Pool Lowering. Significant increases in gasoline supply can be achieved by lowering the octane of the final product slate, since approximately 5 percent of the energy in the feedstock is consumed in the reforming step. Octane lowering has been also suggested on a seasonal basis.

It has been estimated that a high percentage of all unleaded vehicles are not satisfied by current octane levels. Thus, if misfueling is indeed performance motivated, any lowering of unleaded octane, be it seasonal or year long, might increase the misfueling rate, particularly if higher octane unleaded fuels are not readily available as an alternative to switching to leaded grades.

Other alternatives are available to dissatisfied owners. They include tradeup to a new vehicle and detuning to reduce knock (generally by spark retardation). The latter act may increase a vehicle's fuel consumption more than the lowering of the octane ration would increase gasoline supply.

III G-2e Offering of an Unleaded Premium Grade. Amoco, Mobil, and Shell market a premium unleaded fuel and several other refiners have test-marketed an unleaded premium fuel in the East. This fuel, with an octane of about 91 (R+M)/2 or higher, seems to have found good market acceptance with many owners of unleaded vehicles. The comments suggested that demand for this grade has been extraordinarily high. It is possible to project a future where the current mix of leaded regular, unleaded unleaded regular, and leaded premium shifts over the next several years to a mix of leaded regular, unleaded regular, and unleaded premium. Marketing representatives of several refiners have announced their intentions to extend unleaded premium into the national market.

IV IMPACTS OF ALTERNATIVES

This chapter summarizes the estimated impact of the various alternatives, covering price and price differential impacts, induced vehicular emissions, general economic impacts, and refining impacts. At the end, social impacts and the outlook for 1985 are discussed, a sensitivity analysis is made, and a summary of impacts is presented.

The impact analysis discusses the absolute levels of impacts by alternative. Within each alternative, the incremental impact of the alternative, compared to the alternative of no action, is discussed. In the impact summary, incremental impacts over the alternative of no action is discussed.

Most of the analysis done in this chapter is based on national average data, since such data are in most cases more statistically reliable than that which is available on a regional basis. However, where regional data are available and analysis is possible, they are provided, with appropriate caveats as to the limited reliability of the presentation.

In order to carry the impact analyses of fuel switching and increased refining activity to meaningful conclusions, an effort is made to show possible impacts in the attainment of national ambient air quality standards in certain problem cities (Washington, D.C., Denver, and Los Angeles in the case of vehicular emissions; Los Angeles and Houston in the case of refinery emissions). These local impacts are in general arrived at by prorating national average price increase, fuel switching and refinery expansion data to these localities and, to the extent possible, supplementing the analysis with some discussion of available local data, again with appropriate caveats as to its reliability.

The impact analysis is performed on the assumption that the supply and demand of gasoline will be in balance in 1980, which is the conclusion of EIA as discussed in Chapter III, section B. However, in order to provide the full range of possible impacts, the analysis of each alternative will also consider possible environmental impacts if a supply shortfall sufficient to cause a leaded/unleaded price differential of 10 cents per gallon is presented.

The analysis for each of the alternatives of the environmental impacts resulting from increased vehicular emissions, which is the principal environmental issue raised by gasoline deregulation, will be presented in the following logical sequence:

1. First, estimates will be made of the expected average increase in costs associated with the production and marketing of gasoline under each of the alternatives, and their expected increases in prices at both the refiner and retailer level.

2. Next, an estimate will be made of the extent to which these average gasoline price increases will be allocated between leaded and unleaded grades of gasoline at the retail pump.

3. From the predicted changes in the leaded/unleaded price differential, an estimation will be made of the rate at which unleaded gasoline only vehicles will misfuel with leaded gasoline. This will be done by applying the fuel switching rates, arrived at in the manner indicated in Chapter III, section C, and Appendix A.

4. An estimate will be made of increased hydrocarbon (HC) and carbon monoxide (CO) emissions resulting from misfueling.*

5. The national emissions data developed will be used to estimate the extent to which three problem cities (Washington, Denver, Los Angeles) will be delayed in meeting National Ambient Air Quality Standards for carbon monoxide and oxidants.

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* The State of California and EPA suggested in their comments on the DEIS that the impacts of increased nitrogen oxides (NO_x) emissions from poisoned 3-way catalytic mufflers be examined. Only 1980 vehicles nationally and several model years of California cars will use 3-way catalytic mufflers to control NO_x emissions.

EPA data for poisoned catalytic mufflers indicate that high NO_x and high HC emissions cannot occur concurrently. HC emissions for 3-way catalysts less than 4 years of age show typical emissions of about 1 gram per mile, a number which also represents NO_x emissions from the same type of catalyst. If the catalyst is poisoned, HC emissions increase to about 8 grams per mile while NO_x emissions also increase to about 4 grams per mile, or, HC emissions increase to about 4 grams per mile while NO_x emissions increase to 8 grams per mile. (EPA data are unclear as to whether intermediate combinations are possible).

Nationally, since the worst case incremental emissions impact in 1980 for HC is .14 million metric tons per year (with HC emissions increasing by a factor of 8 for poisoned catalysts), NO_x can be expected to increase by a factor of 4 to 8 (but only for one model year of 6 catalyst-equipped model years). Thus, the corresponding worst case incremental impact for NO_x emissions in 1980 is approximately .02 million metric tons per year, an insignificant increase compared to current national emissions of about 25 million metric tons per year.

In California, however, with a larger 3-way catalyst equipped vehicle fleet, incremental NO_x emissions impacts will be about half those predicted in this EIS for HC emissions impacts in California.

IV A Expected Price and Price Differential Increases Under Each Alternative

The point of departure for any impact analysis of deregulation and its alternatives is to determine the expected increases in the average price of gasoline generally and then to determine the extent to which this average price increase will in fact be allocated between leaded and unleaded gasoline.

There are many possible means that could be employed to estimate what price increases will occur over the next two years. Since we have previously determined (Chapter III, section B) that supply and demand for gasoline will likely be in relative balance through 1980, we have decided to estimate refiner price increases on the basis of what refiner's cost increases will be during the next two years. This method is chosen because, in a competitive market, if the supply/demand balance remains relatively constant, cost increases that are common to all members of the industry will be passed through fully. Thus, in the case of refiners, in the analysis that follows we have attempted to identify those cost increases that will in general be common to all refiners and to estimate the amount of the increases.

Price increases that might occur at the retail level have been treated differently, because it is difficult to identify those cost increases that will be common to all retailers. Instead the analysis attempts to establish increases that will be added at the retail level by projecting what average dealer gross income would be in 1980 if it follows the established historical trend of average dealer gross margins and then computing the amount by which a dealer will have to raise his gasoline prices in order to realize the projected gross margin.

From a combination of the refiner and retailer estimates, which provides the total expected price increases at the retail pump, we will estimate the extent to which the price differential between leaded and unleaded gasoline will increase.

There are four principal sources of increased costs which can be anticipated over the next two years:

1) Crude Oil. The principal elements of crude oil cost increases are (i) foreign oil price increases, which are determined primarily by OPEC; (ii) domestic oil price increases, which for uncontrolled oil increases at approximately the OPEC rate, and which for controlled oil increases at the rate of domestic inflation; and (iii) the fact that an increasing proportion of the nation's total crude oil supply is uncontrolled foreign or domestic oil. DOE's decision on deregulation or gasoline tilt will not affect the magnitude of these costs, but it will affect the amount that will be allocated to gasoline as opposed to other products.

2) Inflation-Increased Nonproduct Costs. The various costs of operating a refinery, including such items as labor, utilities and interest expense, will increase over the next two years solely as a result of inflation. Again, DOE's decisions on the proposed actions will affect only how much of these increases, which will be the same in any event, will be allocated by refiners to gasoline.

3) Lead Phasedown Compliance. Significant investments are required by refiners in order to meet the EPA lead phasedown

schedule, which will be met through a substantial reduction in the lead content of leaded gasoline, as well as through the natural increase in unleaded gasoline production dictated by the increased fleet of catalyst-equipped vehicles. Over the next two years, these costs will consist of the costs associated with "debottlenecking" present refineries in order to increase their octane yields and recovering a rate of return on investments in new capacity that have been made to date. Since investments in capacity that will be available through 1980 have already been made, these costs will also exist regardless of whether DOE adopts either of the proposed actions, and the difference will be merely how costs are allocated among products.

4) Dealer Cost Increases. Dealers will also incur cost increases of various kinds over the next two years due to inflation and other factors. These increases, calculated in this analysis indirectly by projecting past trends of dealer gross income, are small compared to refiner cost increases.

The analysis in this section assumes that only cost-justified price increases will occur. Price increases that might result from a supply/demand imbalance (and therefore are not cost-justified) will be considered separately in Section B of this Chapter as part of the analysis of the environmental effects of each alternative.

IV A-1 Expected Cost-Based Price Increases at the Refiner Level

Expected cost increases at the refiner level are summarized in Table IV A-1. The numbers were arrived at through the methodology described below.

IV A-1a Refiner Crude Oil Cost Increases 1978-1980

The composite acquisition costs of crude petroleum by the average refiner is in general equal to the national weighted average delivered price of domestic and imported crude petroleum. The refiner acquisition cost of domestic crude petroleum is the price paid by refiners for domestic crude oil and includes transportation costs from the wellhead to the refinery.*

In the DEIS, we estimated that the average crude oil acquisition cost for refiners would increase by about 15 percent between 1978 and 1980. This figure was arrived at as follows:

The composite acquisition cost of domestic crude petroleum will vary from month to month depending on the weighted average of lower tier, upper tier, and stripper well crude oil prices, plus changes in transportation costs. The increase in the average domestic crude oil acquisition cost for the year 1977 compared with the average for 1975 was

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* Refiner "product" costs for purposes of DOE regulations include also the cost of purchased product, as well as feedstocks. For purposes of this analysis, it is assumed that price increases for purchased products will not deviate in significant amounts from increases in crude oil prices and for simplicity need not be considered separately.

TABLE IV A-1. POTENTIAL INCREASES BETWEEN 1978 AND 1980 IN REFINER PRICES FOR GASOLINE RESULTING FROM CHANGES IN PRODUCT AND NONPRODUCT COSTS FOR ALTERNATIVE ACTIONS (cents per gallon)

	No Action	Gasoline Tilt	Deregulation	Controlled Price Differentials	Controls on Unleaded Gasoline Only
Allowable Product Cost Increases	6.4 [a]	7.0 [b]	7.0 [b]	7.0 [b]	7.0 [b]
Probable Nonproduct Cost Increases	2.4 [a]	3.6 [c]	3.6 [c]	3.6 [c]	3.6 [c]
Total Increases Before Adjustments for Prior Cost Increases	8.8	10.6	10.6	10.6	10.6
Adjustments for Prior Cost Increases	0.0	1.6 [d]	1.6 [d]	1.6 [d]	1.6 [d]
Total Increases	8.8	12.2	12.2	12.2	12.2

(a) Analysis Memorandum AM/ES/79-17, "Motor Gasoline Prices Through 1980 Under Continued DOE Price Controls," EIA, January 1979, plus one-half of added costs of lead phasedown (Appendix E) that can be allocated under the regulations to gasoline.

(b) Application of refiners' expected tilt to gasoline of product costs (110%) (see section IV A-1a).

(c) Application of refiners' expected tilt to gasoline of nonproduct costs (see section IV A-1b).

(d) One time only price increases expected to result upon implementation of action to reflect more appropriate allocation of current costs.

13.8 percent.* The refiner acquisition cost of imported crude oil is the delivered price, including transportation costs, fees and any other costs incurred in purchasing and shipping crude oil to the United States. The increase in the average acquisition cost of imported petroleum for the year 1977, compared with the average for 1975, was 4.3 percent.** (One OPEC price increase occurred during this period.) Due to the increased percentage in refinery feedstocks of much higher priced imported crude petroleum in 1977 compared with 1975, the percentage increase in the composite refiner acquisition cost of domestic and imported crude petroleum over that time period was higher than the price increase for either of the two components, or 15.2 percent.*** In the DEIS, it was assumed, because of the inability particularly to predict the future course of OPEC price increases, that the increase over the next two years would be similar to that experienced between 1975 and 1977, or about 15 percent.

The OPEC price increase announced in December 1978 requires revision of the crude oil price increase estimates used in the DEIS. OPEC announced that it was increasing crude oil prices by 5 percent on January 1, 1979, 3.809 percent on April 1, 1979, 2.294 percent on July 1, 1979 and 2.691 percent on October 1, 1979, for an effective increase by the end of 1979 of about 14.5 percent. This meant that the factor we used in the DEIS to estimate foreign crude oil price increases was too low, even if OPEC does not raise prices again in 1980.

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* $9.55 per barrel versus $8.39 per barrel. (Source: Monthly Energy Review).

** $14.53 per barrel versus $13.93 per barrel. (Source: Monthly Energy Review).

*** $11.96 per barrel versus $10.38 per barrel. (Source: Monthly Energy Review).

The EIA has analyzed the effect of the OPEC increase on gasoline prices (assuming continuation of controls) in a recent Analysis Memorandum.* The results of this analysis have been used to develop the estimates in Table IV A-6. In the most extreme case, using an assumed "high case" rate of domestic inflation (which dictates the rate at which prices of domestic price-controlled crude oil will increase) and an assumed further OPEC increase in 1980 at the rate of domestic inflation, the incremental refiner acquisition cost by the end of 1980 would be about $2.70 per barrel, or 6.4 cents per gallon. Under the assumptions of a low inflation rate and no OPEC increase in 1980, the projected increased crude oil costs would be 4.7 cents per gallon. For purposes of this analysis and in order not to understate the potential environmental impacts, the higher figure is used.

<u>IV A-1b Refiner Nonproduct Cost Increases 1978-1980</u>

Refiners will be required to incur certain increases in nonproduct costs in order to be able to meet product demand in 1980.

The EIA Analysis Memorandum in Appendix G has analyzed refiner nonproduct cost increases by inflating historical refiners' gross margins (refinery gate prices minus average crude oil costs) quarterly with the projected GNP price deflator. By the end of 1980, these costs could amount to as much as 2.2 cents per gallon of gasoline (assuming

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* Analysis Memorandum AM/ES/79-17, "Motor Gasoline Prices Through 1980 Under Continued DOE Price Controls," Energy Information Administration, Washington, D. C., January 1979. A copy of this Analysis Memorandum is attached to this EIS at Appendix G.

continuation of present controls and volumetrically proportional allocation of costs) under low economic growth, high inflation assumptions. The expected range is from 1.7 cents to 2.2 cents per gallon. The higher figure is used in this analysis.

A significant new nonproduct cost increase associated with the production of gasoline that was not fully accounted for in the EIA analysis is the additional cost that will be incurred by refiners in complying with the mandated EPA lead phasedown requirement scheduled for October 1, 1979, and the related need to improve clear pool octane levels. By October 1, 1979, the allowed pool lead content of gasoline will be reduced to 0.5 grams (g) per gallon for complying refiners. Because of temporary exemptions given to small refiners, the average for the industry is expected to be 0.59g per gallon in 1980, down from the present 1.20g per gallon.

A detailed analysis was made to estimate the nonproduct cost increases for the total gasoline pool in 1980 associated with the lead phasedown. This analysis is presented in Appendix E. In general, the analysis concluded that actual nonproduct cost increases associated with improving gasoline refining capability will be about 1.2 cents per gallon of all gasoline produced.*

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* Comment received that critized the size of the cost increases projected in the DEIS caused us to review again carefully the estimates made of nonproduct cost increases. As a result of this review, two changes were made. First, the DEIS relied solely on the costs of complying with the lead phasedown requirements to estimate nonproduct cost increases. We have concluded that it should also include the nonproduct cost increases derived in the EIA Analysis Memorandum by multiplying average refiner margins by the projected rate of inflation, since these are nonproduct cost increases that will be incurred by all refiners. Second, the costs of complying with the lead phasedown schedule have on further analysis been shown to have been overstated in the DEIS. The DEIS number of 1.6 cents per gallon has been revised downward to 1.2 cents per gallon as explained in Appendix E.

IV A-1c Passthrough Permitted Under Various Alternatives

IV A-1c(1) No Action. The pre-December 1, 1978 regulations require that allowable increased product and nonproduct costs be passed through to each product in proportion to its share of the total product volume. (Nationally, gasoline comprises 42 percent of total refinery product output, and it is assumed that this percentage will not change by 1980.) Moreover, costs allocated to other controlled products can be reallocated to gasoline. Currently only about half of refinery product volume, including gasoline, is controlled. For purposes of the analysis, it is assumed that some of the costs allocated to other controlled products would be reallocated to gasoline such that 45 percent of all product and nonproduct costs would be allocated to gasoline.

The 6.4 cents per gallon increased crude oil cost arrived at in the Analysis Memorandum represents an allocation of 45 percent of total increased crude oil costs to gasoline.

A return on new equity investment is not allowed as an increased nonproduct cost under current regulations. However, since added interest costs per gallon of total product can be passed through in volumetric proportions to gasoline, it is assumed that all additional investment is financed by debt at a 9 percent interest rate, the current average yield to maturity of a sample of oil company bonds. Our estimate of the amount of the expected 1.2 cents per gallon of nonproduct cost increases necessary for compliance with the lead phasedown requirement that could be passed through under existing regulations is 0.5 cents. It is also estimated that roughly 0.3 of the 0.5 cents per gallon increase may be included in the total nonproduct cost increase of 2.2 cents per gallon estimated by the EIA in the Analysis Memorandum, leaving 0.2 cents per gallon to be added. Thus, the total nonproduct increase allocated to gasoline would be about 2.4 cents per gallon.

Thus, the total estimated crude oil and nonproduct cost increases that would be allocated to gasoline by 1980 under continuation of current price controls would be 8.8 cents per gallon. This number and its two components are presented in the first column of Table IV A-1.

IV A-1c(2) Tilt. Under the gasoline tilt proposal, the amount of allowed product and nonproduct costs that could be allocated to gasoline is larger than the volumetric proportion. If a refiner produces 42 percent gasoline, the national average, it can pass through 110 percent of the amount of crude oil cost increases it could pass through if only volumetrically proportional allocation were allowed, and approximately 150 percent of the total nonproduct costs it could pass through on a volumetrically proportional basis.

In this analysis, it is assumed that refiners will take full advantage of the tilt allowed for crude oil costs and pass through 7.0 cents per gallon (6.4 cents times 110 percent). It is also assumed for purposes of this analysis that if it is allowed to do so under the regulations, a refiner will attempt to recover in gasoline sales only as much of the cost of complying with the lead phasedown schedule as possible, but that, with regard to inflation-adjusted increased nonproduct costs generally, the competitive conditions for gasoline relative to other products will not allow it to take advantage of the full 150 percent tilt to gasoline. Rather, we estimate the tilt of general nonproduct costs will be about 125 percent. Thus, the amount of general nonproduct costs that will be passed through on gasoline will be 2.4 cents (1.9 cents, the amount of general nonproduct costs (2.2 cents total) that does not include a factor for compliance with lead phasedown, times 125 percent), plus the full 1.2 cent cost of complying with lead phasedown, or a total of 3.6 cents per gallon, if that much is permitted under the tilt regulation. It happens that exactly that much is allowed as a result of additional increased nonproduct costs between the fourth quarters of 1978 and 1980 (calculated by multiplying the 2.4 cents allowed under volumetrically proportional allocation times 150 percent, or 3.6 cents).

The increased crude oil costs (7.0 cents) and the increased nonproduct costs (3.6 cents) that would be allocated to gasoline, plus the total of 10.6 cents, are shown on the first three lines of column two of Table IV A-1.

In addition to allowing more than a volumetrically proportional allocation to gasoline of future product and nonproduct cost increases, which is reflected in the foregoing figures, the gasoline tilt rule will also allow a refiner to make an immediate adjustment upward in the amount of such costs that it allocates to gasoline to reflect cost increases that have already been incurred between May 1973 and the present. Another way to look at this increase is that the first month the gasoline tilt rule goes into effect, refiners could immediately begin allocating to gasoline an additional amount of increased costs. This "up-front" adjustment is not included in the foregoing discussion of nonproduct cost increases, which deals only with increases that will occur after the rule goes into effect. For the average refiner, the maximum allowable adjustment has been estimated to be 1.7 cents per gallon for product costs and 2.2 cents per gallon for nonproduct costs. DOE has concluded, however, that competitive conditions will probably not permit refiners to pass through this full allowable adjustment, and it is estimated, based upon historical allocation of product and non-product costs during a period when the regulations allowed full flexibility, that the adjustment will in fact average 1.2 cents and 0.4 cents per gallon respectively, or a total of 1.6 cents per gallon, as shown on line four of column two, Table IV A-1.(II-2)

Thus, the total expected adjustment by refiners under the gasoline tilt regulation, reflecting both product and nonproduct costs increases, is 12.2 cents per gallon of gasoline.

IV A-1c(3) Decontrol, Fixed Differential, and Fixed Price for Unleaded. Under each of these alternatives, no controls would exist on the passthrough of costs by a refiner. Presumably, a refiner will strive to pass on the total cost increase calculated using historic return on investment. Of course, the market situation, not his costs, determines whether he can pass through all, only part, or more than the costs calculated here. For purposes of this analysis, however, it is assumed that full cost passthroughs are possible.

In a deregulated environment, the assumptions as to crude oil cost increases that would be passed through on gasoline are the same as under the tilt alternative, or 7.0 cents per gallon. The same is true for nonproduct costs and the initial upward adjustment in cost allocations that refiners are likely to make as soon as the alternative becomes effective.

Thus, as shown in the last three columns of Table IV A-1, under these alternatives refiner prices could be expected to rise by essentially the same as under tilt, or 12.2 cents per gallon between 1978 and 1980.

IV A-2 Expected Price Increases at the Retail Level

IV A-2a Conceptual Framework. Although costs increases are likely to occur at the retail level which will influence gasoline pump prices, it is difficult to identify such potential cost increases and, because of the great disparity among retail dealers, it is also less certain than in the case of refiners that these cost increases will necessarily be reflected in price increases. Thus, the cost-related price increase approach used in the analysis at the refiner level in the preceding section will be abandoned here in favor of projections of likely average dealer margin increases based upon historical trends.

The line of reasoning taken in this analysis is as follows: retail service stations on the average will maintain some minimal level of total net income from gasoline sales. If the number of dealers and the level of gasoline demand that is satisfied through dealer sales is known, it is possible to determine the average gallonage sales per dealer and, in turn, the average real (that is, inflation adjusted) dealer margin per gallon of gasoline sold. This latter figure then can be converted to current dollar terms by use of the appropriate price index. Any increase in dealer current gross margins can be added to expected refiner price increases estimated in the preceding section to determine total average price increases expected at the gasoline pump.

IV A-2b Baseline Situation. Table IV A-2 provides certain baseline data regarding historical trends in numbers of dealers, volumes of gasoline sold, dealer margins, etc., that are necessary for further analysis.* Some significant observations can be drawn from the data presented in this table:

1. The number of retail dealers generally increased until 1973, when Phase IV price controls were imposed by the Cost of Living Council and continued thereafter by FEA and DOE. Since 1972, the number of dealers has fallen from 226,459 to 171,000. (Column 1)

2. Since total gasoline volume sold through retail dealers has steadily increased and the number of dealers has declined, the average volume sold per dealer has increased dramatically, from 294,305 gallons in 1973 to 431,930 estimated in 1978. (Column 3)

3. Average real dealer margins per gallon have declined steadily as volumes have increased. (Column 5)

4. Average real gross income per dealer (income before deduction of operating expenses) has gradually increased over the ten year period, from about $20,000 in 1968 to $24,000 in 1978, with the exception of 1973-74, when the oil embargo and subsequent crude oil price increases disrupted market conditions.

The principal trends that can be derived from the data presented in Table IV A-2 are presented graphically in Figure IV A-1.

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* The figures shown were presented in the DEIS. Assumptions as to gasoline demand for 1978, the rate of inflation in 1978 and the projected rate of inflation could have been revised somewhat to reflect actual 1978 gasoline demand, the actual 1978 inflation rate (9 percent) and more recent estimates of future inflation. However, the ultimate results of the analysis are not sensitive to these relatively minor adjustments.

IV A-2c Projected 1980 Retail Margins. The next step in determining potential price increases is to project 1980 dealer margins under regulation and deregulation alternatives. To arrive at these estimates, certain assumptions have to be made. The first is that, under continued regulation, the number of retail dealers will decline at the 1977-78 rate during 1978-79 and 1979-80. The second is that, under deregulation, the number of gasoline dealers in 1979-80 remains unchanged at the 1978 level.

The regulation and deregulation projections for 1980 must also be based on the assumption that dealers receive average gross real incomes from the sale of gasoline at 1978 levels ($24,188 in 1972 dollars). This assumption is considered valid, since this amount represents the continuation of a long-term trend in average dealer real gross margins that appears not to have been significantly affected by the imposition of controls. Figure IV A-1 shows that the average gross income per dealer from gasoline sales has followed a consistent linear trend line with the exception of the embargo period. Assuming adequate supplies of gasoline are available in 1979-80, it would appear likely that market competition will restrict average dealer income to the long-term trend.

Both projections also assume that total demand for gasoline changes between 1978 and 1979 as projected by DOE (Supplement, p. S-46) and between 1979 and 1980 it will continue to change at the same rate; and that 66 percent of total demand is sold through dealers. Finally, it is assumed that the rate of inflation will be 8 percent in 1977-78 7 percent in 1978-79, and 6 percent in 1979-80.

TABLE IV A-2. BASELINE DATA: 1969-78 DEALER-MARGINS

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Year	Number of Gasoline Stations	Gasoline Sold thru Dealers (million gal.)	Average Sale of Gasoline per Dealer (gals.)	Aver. Real Gross Income Per Dealer (1972 $'s)	Aver. Real Dealer Margin (1972 ¢/gal.)	GNP Deflator for (1972 = 100)	Average Margins (Current cents/ gal.)
1968	219,000	55,861	255,073	20,074	7.87	82.6	6.5
1969	222,200	58,335	262,534	20,268	7.72	86.7	6.7
1970	222,000	60,868	274,180	20,097	7.33	91.4	6.7
1971	220,000	63,203	287,286	21,230	7.39	96.0	7.1
1972	226,459	66,648	294,305	19,718	6.70	100.0	6.7
1973	215,880	69,572	322,272	22,527	6.99	105.8	7.4
1974	196,130	68,215	347,805	29,076	8.36	116.0	9.7
1975	189,460	68,756	362,868	23,949	6.60	127.2	8.4
1976	186,400	70,748	379,349	21,547	5.68	133.8	7.6
1977	176,450	72,541	411,114	24,091	5.86	141.6	8.3
1978	171,000	73,860	431,930	24,188	5.60	152.9	8.6

Sources & Notes:

(1) from NPN Fact Books: 1977, p. 92 and 1978, p. 103.

(2) from the May 1978 Supplement to the September 1977 Findings and Views on Motor Gasoline Exemption, p. S-27 (Ref III-5) Full-year data for 1975-6; part-year data for 1974-77. Full years 1974 and 1977 estimated from full/part ratios. 1968-73 estimated as 68% of total demand: 1978 estimated as 66% of total demand. Total demands estimated by DOE (Supplement, p. S-46).

(3) =(2)/(1)

(4) =(3) x (5)

(5) =100 ((7)/(6) for 1968-77; 1978 projected graphically.

(6) Total GNP Deflator (1972=100) from National Income and Product Table 7.1 (U.S. Dept. of Comm. BEA). 1978 set at 8% above 1977.

(7) from Supplement, p. S-13, for 1968-77; 1978 backed-out from (5) x (6).

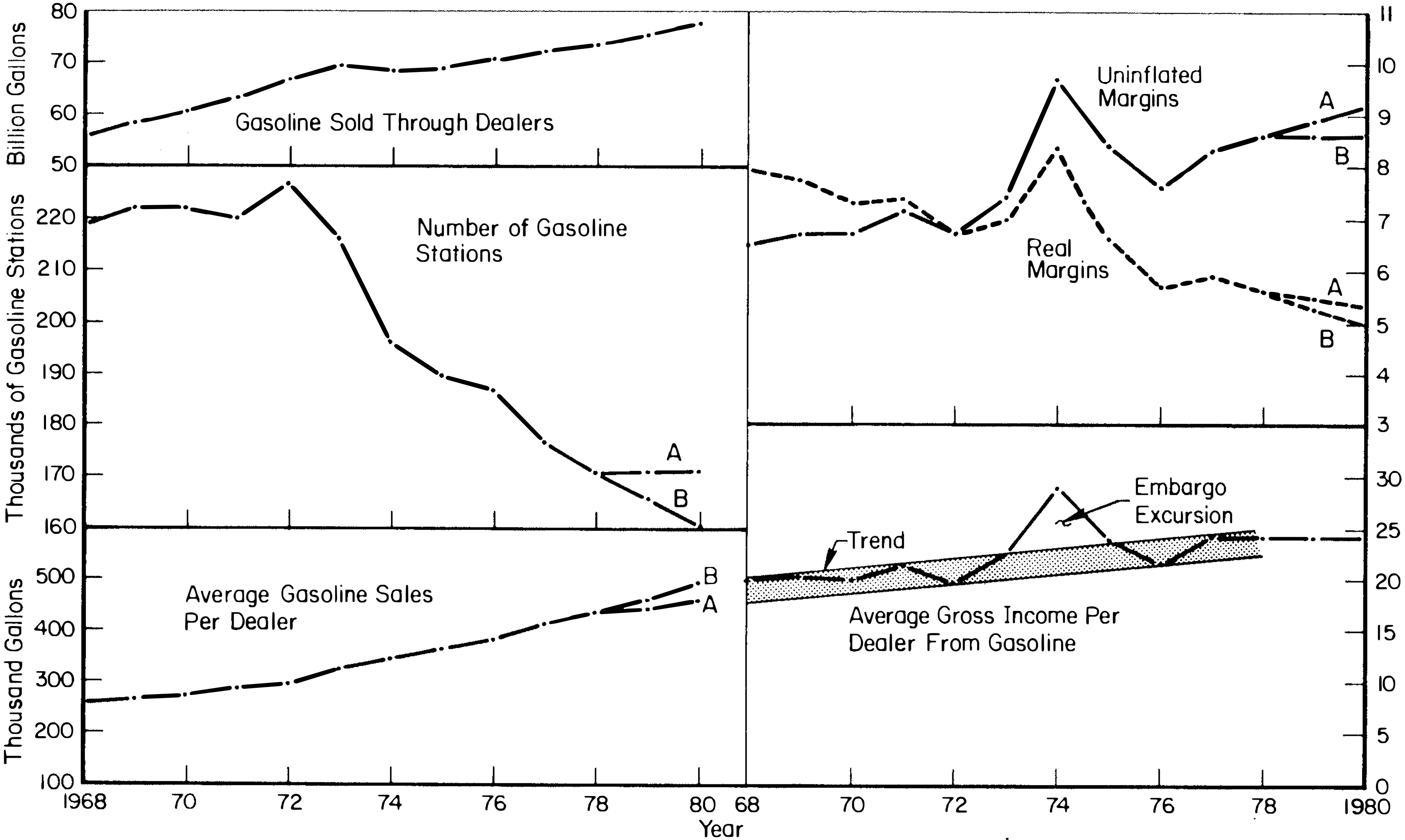

FIGURE IV A-1. **SALIENT STATISTICS ON DEALER OPERATIONS AND MARGINS, 1968-1978 WITH PROJECTIONS TO 1980 UNDER ALTERNATIVE SCENARIOS**

IV A-2c(1) Deregulation Alternative. The deregulation alternative gives rise to the 1978-80 projections shown in Table IV A-3. The assumptions made above imply the following 1978-80 values:

1. In Column 1, number of stations is constant at 171,000.

2. In Column 2, there is an increase in the sale of gasoline by dealers from 73,860 million gallons in 1978 to 78,120 million gallons in 1980, with corresponding increases in average dealer gallonage (Column 3) from 431,930 in 1978 to 456,842 in 1980.

3. Average real (1972 dollar) gross income per dealer from gasoline (Column 4) remains constant at $24,188 in each year.

4. Given the entries in Columns 3 and 4, real margins (Column 5) fall from 5.60 cents per gallon in 1978 to 5.29 cents per gallon in 1980.

5. The GNP deflator index (Column 6) rises from 152.9 percent of 1972 in 1978 to 163.6 percent in 1979 and 173.5 percent in 1980.

6. Given Columns 5 and 6, current margins on gasoline rise from 8.6 cents per gallon in 1978 to 9.2 cents per gallon in 1980.

IV A-2c(2) No Action (Continued Regulation) Alternative. The projection for this alternative differs from the projection in the DEIS in that the rent passthrough rule became effective on January 1, 1979. The DOE has calculated a maximum credible increase in retailer margins of 0.67 cent per gallon for rent passthrough and believes the most likely increase to be 0.1 to 0.3 cents.[II-3] Assuming an average margin increase of 0.2 cent per gallon, the number of stations would decline from 171,000 in 1978 to 164,392 in 1980, compared with a constant number of stations at 171,000 in the deregulation alternative. This change in the assumptions implies the following values as shown in Table IV A-3:

1. Entries in Columns 2, 4, and 6 are the same.

2. Given Columns 1 and 2, average gallonage sold per dealer (Column 2) increases much faster than under the deregulation alternatives, rising from 431,930 gallons in 1978 to 475,206 gallons in 1980. This latter figure is 4.0 percent higher than the corresponding gallonage under the deregulation projection.

3. Given Columns 3 and 4, average real dealer margins per gallon (Column 5) would tend to fall faster than the margins reached under the deregulation projection, reaching 5.09 cents in 1980.

4. Average margins in current dollars will be 8.8 cents per gallon compared with 9.2 cents per gallon under deregulation.

IV A-2d Summary. The time series trends and the assumed projection of the number of stations are combined in Figure IV A-1 to show projected 1980 dealer margins for the deregulation and no action alternatives. The projections for all alternatives can be summarized as follows:

(1) Under the no action alternative, including rent passthrough, the projected retail margin for gasoline is 8.8 cents per gallon, averaged over the nation. (Table IV A-3, Col. 7)

(2) Under the gasoline tilt alternative, the effect will be the same as under the no action alternative, since controls at the retail level would remain unchanged.

(3) For the deregulation alternative, the projected retail margin is 9.2 cents per gallon, averaged over the nation, or a 0.4 cent per gallon increase over the no action alternative. (Table IV A-3, Col. 7)

(4) Under the alternative of maintaining retail price controls on unleaded gasoline only, projected retail margins are likely to be somewhere between the no action and deregulation alternatives. This is because continued controls on only one product are likely to cause some

TABLE IV A-3. PROJECTIONS OF 1979-80 DEALER MARGINS

Year	(1) Number of Gasoline Stations	(2) Gasoline Sold thru Dealers (million gal.)	(3) Average Sales Per Dealer (gals)	(4) Aver. Real Gross Income Per Dealer (1972 $'s)	(5) Aver. Real Dealer Margin (1972 ¢/gal.)	(6) GNP Deflator for (1972 = 100)	(7) Average Margins (current cents/ gal.)
Deregulation: Average number of stations held at 1978 level with constant real net per dealer.							
1978	171,000	73,860	431,930	24,188	5.60	152.9	8.6
1979	171,000	75,884	443,766	24,188	5.45	163.9	8.9
1980	171,000	78,120	456,842	24,188	5.29	173.5	9.2
No Action: Number of stations assumed to decrease at 1977-78 rate with constant real net per dealer.							
1978	171,000	73,860	431,930	24,188	5.60	152.9	8.6
1979	169,411	75,884	447,926	24,188	5.40	163.6	8.8 (8)
1980	164,392	78,120	475,206	24,188	5.09	173.5	8.8 (8)

Sources & Notes:

Column	Deregulation	No Action
(1)	Held constant at 1978	By assumption each year is .969 of previous year.
(2)	For 1978-80 is 66% of total gasoline demand. Demand for 1978-9 from supplement p. S-46; for 1980 estimated with 1978-9 rate of increase.	Same as under deregulation
(3)	= (2)/(1)	Same as " "
(4)	Held constant at 1978.	Same as " "
(5)	= (4)/(3)	Same as " "
(6)	Assumed to increase by 7% from 1978-9 and by 6% 1979-80	Same as " "
(7)	= (5) x (6)	Same as " "
(8)	with recently adopted rent passthrough regulation	

continued decline in the number of retail stations, but not at previous rates. Since a precise estimate of projected margin under this alternative is purely speculative, however, and because any difference from the deregulation alternative would be of no significance in the succeeding analysis, it will be assumed that dealer margins under this alternative will also be the same as under deregulation.

(5) For the mandated retail price differential alternative, it can reasonably be expected that the regulatory burdens imposed will not cause the same decline in the number of retail stations that is assumed to result from the no action alternative. The retail margin under this alternative has been assumed to be the same as for deregulation -- 9.2 cents per gallon averaged over the nation.

IV A-3 Projected Increases in Leaded/ Unleaded Price Differential

Total expected average gasoline price increases in 1980 can be summarized from the preceding two subsections as follows:

Alternatives	Attributable to Increases in Refiner Costs	Attributable to Increases in Dealer Margins	Total
No Action, Including Rent Passthrough	8.8¢	0.2¢	9.0¢
Gasoline Tilt	12.2¢	0.2¢	12.4¢
Deregulation	12.2¢	0.6¢	12.8¢
Fixed Price Differential	12.2¢	0.6¢	12.8¢
Fixed Price Margin	12.2¢	0.6¢	12.8¢

The total expected price increases shown above are average per gallon price increases for the gasoline pool as a whole. The figures shown in the totals column could vary by approximately plus or minus 0.5 cents.

The next step in the analysis is to determine whether refiners and marketers of gasoline in 1980 are likely to increase the prices on all grades of gasoline by the average amounts shown, or, rather whether they will "allocate" more of the expected average price increases to leaded or to unleaded grades of gasoline. As will be seen below, it is at this stage of the analysis where the greatest degree of uncertainty exists. In order to avoid the possibility of overlooking environmental impacts, effort is made in the following analysis to resolve uncertainties in the direction of showing larger increases in the price of unleaded gasoline relative to leaded price increases, thus increasing the price differential.

At the present, the national average price differential* at full service pumps is 4.4 cents per gallon** and at self serve pumps is 5.2 cents per gallon. Weighted average differential data for both full serve and self serve are not available over the past three years, but the arithmetic average differential at full serve pumps alone is known to have increased by 0.9 cents per gallon between, on the one hand, the 6-month period February through July 1975, and, on the other hand, the corresponding period in 1978 (from DOE Monthly Energy Review, October 1978, pp. 65-66). It is believed that the weighted average has changed similarly. (Over this period most sales have been at full serve pumps.) Between these same periods, retail gasoline prices at full service pumps have increased about 8.55 cents per gallon (the arithmetical average of leaded and

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* This is a station-by-station average. The trend toward high volume stations may cause the gasoline volumetric sales averaged price differential to be smaller.

** As indicated in Chapter III, the standard deviation among stations is 1.9 cents--that is, 66 percent of all stations have full serve differentials between 2.5 and 6.3 cents per gallon. There is also some variation in the size of the average price differential among different regions of the country, as shown on Table IV A-4 for the first six months of 1978.

unleaded gasoline price increases*). These data would suggest that the ratio between increases in gasoline prices and increases in the differential during this period was about 8.55 to 0.9. Stated differently, the historical data would indicate that the price of unleaded gasoline increased in an amount equal to not more than 105 percent of the amount that the pool average gasoline price increased. To be sure, the fact that data derived during a period in which price controls have been in effect indicates a shift-to-unleaded factor of 105 percent does not necessarily mean that the same factor will apply when price controls are lifted. It should be noted that refiners are free under current regulations to shift costs from leaded to unleaded gasoline. The National Oil Jobbers Council and a number of refiners commented that deregulation should have little effect on the differential since the major cause of the high price differentials is the low prices being charged for the "loss leader" leaded gasoline.

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* The arithmetic average of these two numbers, rather than the weighted average, is considered appropriate in this analysis because by 1980 unleaded gasoline is expected to constitute 50 percent of total gasoline sales, and therefore the shift to unleaded will not have to be as pronounced in order for retail dealers to realize the same gross income.

TABLE IV A-4. LEADED/UNLEADED PRICE DIFFERENTIAL AVERAGES BY DOE REGION FOR FIRST SIX MONTHS OF 1978 (CENTS PER GALLON)

	DOE Region	Full Service	Self Service
1	(New England)	4.1	5.0
2	(New York, N.J.)	4.3	5.6
3	(Middle Atlantic)	3.8	5.4
4	(Southeast)	4.5	4.6
5	(South Central)	4.2	3.8
6	(Central)	3.6	4.6
7	(North Central)	4.0	3.7
8	(Rocky Mountains)	3.1	3.1
9	(Pacific Southwest)	4.0	4.7
10	(Pacific Northwest)	3.9	3.9
	National Average	4.2	4.7

Although price motivated fuel switching behavior is influenced only by price differentials at the retail level rather than the refiner level, changes historically in the differential at the refiner level are useful in estimating future changes in the retail differential. DOE has aggregated refiners' national weighted average dealer tankwagon (DTW) prices for unleaded and leaded gasoline (taken from DOE Form P-302) and has calculated refiner price and price differential changes averaged over time. From the period September 1975 through August 1976 to the corresponding period September 1977 through August 1978, the pool arithmetic average DTW price increase was 5.3 cents per gallon

The average refiner price differential increase between these two periods was 1.67 cents per gallon. The average unleaded gasoline DTW price increase between these two periods was 6.2 cents per gallon. Therefore, between these two periods, refiners increased their unleaded gasoline DTW prices in an amount equal to approximately 117 percent of the pool average DTW price increase. It appears, therefore, that the shift of prices to unleaded gasoline has been more pronounced at the refiner level than at the retail level. The relationship between increases in the price differential at the retail and refiner levels is shown in Figure IV A-2. It also appears that the price regulations have not constrained the shift to unleaded prices at the retail level, because retailers are permitted to pass through in their prices for a particular grade of gasoline their entire purchase cost for that grade of gasoline and have not been doing so to the same degree as refiners.

In the future, the shift to unleaded factor at the retail level is likely to be more predominant than the refiner factor when the two approach the point of interseption, since the retail differential is more reflective of the cross-elasticity of consumer demand between these two products.

Therefore, for purposes of this analysis, future price differentials projected on the basis of the retail factor are considered more likely. However, it is also possible that the refiner shift-to-unleaded factor would begin to prevail as the two reach the point of intersection.

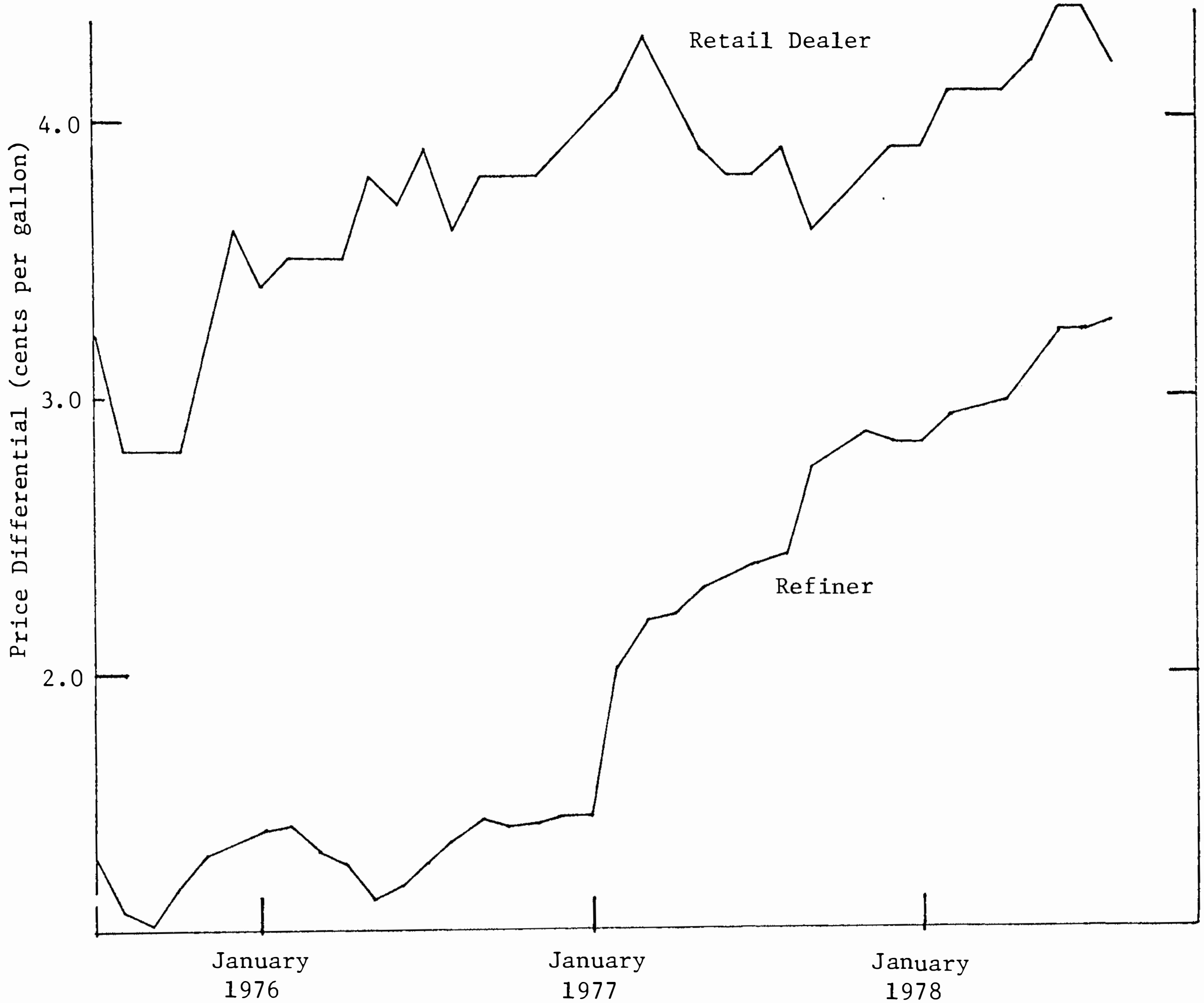

FIGURE IV A-2. HISTORICAL REFINER AND RETAILER UNLEADED/LEADED REGULAR PRICE DIFFERENTIAL

There is some support for this in Figure IV A-2, which shows that since the summer of 1977 the retail differential tended to parallel the change in the refiners' differential. Therefore the subsequent fuel switching effects if this trend continues are also considered in this EIS.*

Applying the historical retail shift factor to the anticipated 1980 price increases developed above yields the projected 1980 retail price differentials shown in Table IV A-5.

As Table IV A-5 indicates, assuming continuation of the historical retail relationship between unleaded price increases and average price increases for gasoline generally, under no alternative will the price differential be as great as 6 cents per gallon. This is of extreme importance in determining the impact on fuel switching because, as shown in Chapter III, available fuel swithcing data are not sufficiently sensitive to indicate any difference in the fuel switching rate <u>within</u> the four-to-six-cent range. Stated differently, if the price differential increased from the present 4.4 cents per gallon to about 5.7 cents per gallon by 1980 (as Table IV A-5 indicates it would for two of the alternatives), there might be some resulting increase in the fuel switching rate, but available data on fuel switching are not sufficiently sensitive to so indicate. Only if the price differential increases to the next

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* Some commenters, including the Center for Auto Safety, have stated that all of expected price increases might be loaded onto unleaded gasoline, thus increasing the differential dramatically. No evidence was presented to support such a theory. We believe it is not a credible possibility, since the present price rules provide sufficient flexibility to shift more costs to unleaded gasoline. Refiners and retailers are not currently taking advantage of this flexibility, and there is therefore no reason to believe they will in the future.

TABLE IV A-5 INCREASE IN LEADED/UNLEADED PRICE DIFFERENTIAL IN 1980 USING HISTORICAL RELATIONSHIP BETWEEN INCREASES IN RETAIL UNLEADED GASOLINE PRICES AND AVERAGE RETAIL PRICE INCREASES FOR BOTH LEADED AND UNLEADED GASOLINE (Cents Per Gallon)

Alternative (a)	1980 Gasoline Price Increase	Historical Shift Factor %	1980 Price Increase for Unleaded Gasoline	1980 Price Increase for Leaded Gasoline	1980 Increase in Differential	Present Differential	1980 Leaded/ Unleaded Price Differential
No Action	9.0	105	9.45	8.55	0.9	4.4	5.3
Gasoline Tilt	12.4	105	13.02	11.78	1.24	4.4	5.64
Deregulation	12.8	105	13.44	12.16	1.28	4.4	5.68
Fixed Unleaded	12.8	105	13.44	12.16	1.28	4.4	5.68

(a) The fixed differential alternative is not relevant to this discussion, since the differential would be regulated at 0 cents or 3 cents per gallon.

highest price differential range for which different fuel switching results are available (the 7-to-9-cent price differential range) would any emissions impact be demonstrable.

Thus, while projections of past retail price trends would not indicate any future change in the price differential sufficient to result in a measurable change in fuel switching among motorists with unleaded only vehicles, it is reasonable to consider whether there is at least a realistic possibility that the price differential under each of the alternatives would reach as high as 7 cents per gallon (the lower end of the 7-9 cent differential range, for which discrete fuel switching probabilities are available) and as high as 10 cents per gallon (the lower end of the "10 cents plus" range, for which a separate set of fuel switching probabilities is also available). The shift percentages that would have to be applied under each of the alternatives to reach these price differential levels are as follows:

Alternative	Average Price Increase	Shift Factor Required to Increase Differential to 7¢	Shift Factor Required to Increase Differential to 10¢
No Action	9.0	115%	131%
Gasoline Tilt	12.4	111%	123%
Deregulation	12.8	110%	122%
Fix Unleaded Margin	12.8	110%	122%

Under each of the alternatives considered (except the controlled differential alternative), the shift needed to attain a 7-cent-per-gallon differential (110-115 percent) is beyond the historical factor of 105 percent at the retail level but is at or below the historical factor at the refiner level (117 percent). Therefore, shifts in this amount are reasonable possibilities.*

As for a 10-cent differential, the shifts that would be required under all the alternatives to reach this level (122 to 131 percent) are well beyond the historical experience at either the retail or refiner level and must be ruled out as not credible, assuming no significant change in relative supply availability of leaded and unleaded gasoline.

However, it is possible under the deregulation alternative only that the differential would increase to 10 cents if there were major supply interruptions (under the other alternatives, pre-existence of some form of controls would likely prevent increases in the prices of unleaded gasoline or both leaded and unleaded gasoline to the point where the differential would increase to 10 cents using the shift factors developed above, see discussion in Chapter III B.) If one assumes a

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* Numerous comments were received on future retail price differentials, ranging from questions of why the differential would increase with increasing crude oil costs to statements that projections from historical data ignore underlying forces which may rapidly change.

No explanation can be given for the particular amount of the retail spread. Retail leaded gasoline at self service pumps is currently discounted below a price which yields an adequate service station margin, and further discounting is not expected. The DOE expects that a 7-9 cent per gallon differential, averaged across the nation, is unlikely in 1980, but acknowledges that such a differential is possible on a nationwide basis and, because of known variations among regions, is likely in some regions of the country.

shift-to-unleaded factor of 11 percent (the mean between the historical retail and refiner shift-to-unleaded levels), then a 28.0 cent total average price increase would result in a 10 cent price differential (that is, if prices rose on the average 28.0 cents and unleaded prices were 11 percent of the average, the unleaded price would increase 30.8 cents, the leaded price would increase 25.2 cents, and the present differential of 4.4 cents would increase by 5.6 cents to 10 cents). A 28.0 cent total average increase would be 15.2 cents above the 12.8 cent cost-based price increase expected under deregulation, and could be caused by such price increases plus a supply shortfall of about 319,000 B/D (assuming, based on estimates of the elasticity of demand for gasoline, that each 21,000 B/D supply shortfall will increase the price one cent).* As noted in Chapter III, EIA's estimates indicate that such a shortfall is not expected, but it could readily develop if there were a major unexpected supply interruption.

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* To reach a differential of 10 cents, if the retail shift to unleaded factor of 105 percent is assumed to predominate, a total average price increase of 56 cents would be needed, which could be caused by a shortfall of 907,000 B/D. On the other hand, if the historical 117 percent refiner shift to unleaded is assumed to predominate, a total increase of 16.4 cents would be needed to attain a ten cent price differential. Subtracting the 12.8 cent cost-justified increase in 1980, the necessary 3.6 cent incremental increase could be caused by a shortage of 77,000 B/D. As can be seen, the differential is quite sensitive to a small percentage change in the allocation of costs to unleaded gasoline.

IV B Economic and Emissions Impacts of Alternatives

IV B-1 No Action Alternative

IV B-1a Price and Price Differential Impacts

As indicated above, the expected retail pump price increase between 1978 and 1980 under the no action alternative is 9.0 cents per gallon, based on allowable crude oil and nonproduct costs increases at the refiner level. Applying the historical shift-to-unleaded factor of about 105 percent of the average price increase, it would be expected that the average price differential under this alternative would increase from 4.4 to roughly 5.3 cents per gallon.*

IV B-1b Vehicular Emission Impacts

Once the price differential range for a given alternative is established, the fuel switching rate is determined by applying the data in Table III C-1. The emissions impact can then be determined by applying the data on increased emissions from misfueled vehicles in the manner indicated in Table III C-2.

Applying this approach to an expected price differential in 1980 of about 5.3 cents per gallon, the resulting national light duty vehicle emission impact for the no action alternative is as follows:

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* To be conservative in estimating impact, we are assuming that the lower shift-to-unleaded factor (the historic factor at the retail level) will prevail under the no action alternative, but, as will be seen below, we are assuming that the higher shift factor (the historic factor at the refiner level) will prevail in the other alternatives. This approach will tend to establish maximum possible incremental impacts.

TOTAL NATIONAL LIGHT DUTY VEHICLE EMISSIONS
UNDER NO ACTION ALTERNATIVE IN 1980
(in Millions of Metric Tons)

	Best Case	Expected	Worst Case
Hydrocarbons	4.60	4.77	4.83
Carbon Monoxide	57.8	58.4	59.0

These data can be compared to estimated national anthropogenic hydrocarbon emissions of 28 million metric tons (MMTm) per year and carbon monoxide emissions of 87.5 MMTm per year.

In the analyses here, "Best," "Worst" and "Expected" cases refer to relative fuel switching probabilities only, as developed in Table III C-1, and do not reflect other possible variables, such as price differential or supply/demand balance. As used here, the three cases are defined as follows:

Best Case. In the "Best" case, the price induced misfueling rate is as low as it can be. Because the methodology allows for the possibility of the population misfueling rate to be very close to zero, the "Best" case represents essentially no misfueling. The likelihood of occurrence of the "Best" case is 1 percent or less.

Worst Case. In the "Worst" case, the misfueling rate is at the outer bound of likelihood, and thus represents the outer extreme of probability. The likelihood of the impact being as large as the "Worst" case is 1 percent or less.

Expected. The "Expected" case represents the highest likelihood result. As the distribution of results tends to be in the form of a bell-shaped curve, the highest probability is that the actual impact will be close to the "Expected" value.

In the discussion later in this section of the vehicle emission impacts of the alternatives to no action, best, expected and worst cases will be developed. In each case, supply and demand is presumed to be in balance unless otherwise noted.

One important point to realize is that the "No-Action" alternative does indeed have an impact. If it is true that the regulatory environment will lead to octane shaving to satisfy demand in 1980, then performance-induced fuel switching will increase.

To the extent that continued regulations (as opposed to deregulation) will exacerbate octane shaving in 1980, there will be performance induced switching. Exact quantification of this impact is not possible with currently available data. The Amoco findings discussed in Appendix A, suggest that a 1 point octane reduction would increase misfueling in the vehicle population by 5 percent, in which case performance is certainly a better indicator of misfueling than price. Although the Amoco data cannot be accepted on face value, the link between performance and misfueling is certainly no less tenuous than that of price and misfueling.

Several of the commenters on the DEIS pointed out that the DEIS inadequately addressed the possible adverse environmental impacts that would result in the future if the no action alternative were chosen and suggested that this impact may be more serious than the potential impacts of deregulation or gasoline tilt. They pointed out that substantial increased investment in downstream gasoline refining capacity will be required if the industry is to meet the steep increase in unleaded gasoline demand that will occur through most of the 1980's and that the present regulations, by in effect limiting refiners to the same net return, including return on investment, they were earning on May 15, 1973, has been in the past and will be a great impediment to new investment. This view is supported by the evidence presented in Chapter III that substantially more reforming capacity than has yet been needed must be added over the next six years to meet unleaded demand and that scheduled refinery expansions in the next two years indicate that the trend in refinery investment has been in the other direction. It is apparently because of a general lag in new investments over the past few years that, as noted in Chapter III, section B, gasoline supplies will be tight over the next two driving seasons if gasoline demand exceeds expectations. If there is a shortfall in needed gasoline refining capacity, it will be manifested first in the unleaded grades. The recent difficulties experienced by some large refiners over the present winter in supplying their customers requirements for gasoline -- while due in part to some extraordinary events and not necessarily an indication of impending future shortages -- demonstrates that the unleaded grades, and particularly the unleaded premium grade preferred by many motorists for performance, will be the first in short supply.

Such supply shortages could have serious environmental consequences, even if the present controls are retained. Those retailers that are not charging their maximum lawful prices for unleaded gasoline will be induced to do so, and those that already are may well chose to exceed them, given the apparent substantial degree of non-compliance occurring presently and the lack of enforcement resources to focus on retail violations. This will increase the leaded/unleaded price differential, thus inducing more price motivated fuel switching. Perhaps more importantly, substantial fuel switching may occur by motorists who are seeking to avoid the inconvenience of finding a service station that has available the grade of unleaded gasoline they would normally purchase.

The adverse environmental impact that might result from shortages of unleaded gasoline is impossible to quantify. There is little doubt, however, that it could, if severe and chronic, result in substantial fuel switching and impairment of catalytic converters.

IV B-1c Economic Impacts

The continuation of regulations unchanged is the baseline case from which economic impacts of the other alternatives will be measured. In other words, baseline estimates of 1980 GNP, inflation and employment assume the no action alternative.

IV B-1d Petroleum Industry Impacts

IV B-1d(1) Economic Impacts. The price of gasoline has historically absorbed a greater proportion of crude and refining costs, relative to its volume, than other refined products have absorbed.

Products accounting for about 50 percent of the total volume of domestic refined product output have already been exempted from controls. Since the volumetrically apportioned costs of exempted products may not be reallocated to gasoline, this has had the effect of lowering the maximum allowable price which could otherwise be charged to gasoline.

Some refiners have expanded their unleaded gasoline production capabilities and modernized their refineries in the expectation that deregulation would have occurred by now and that they would thus have an opportunity to recover their return on capital investment, if market competition permits. Apparently many others have plans that would be initiated in a more favorable climate.

As noted above, failure to take positive action to remove price and allocation controls will reduce incentives to invest in new capacity needed to maintain adequate supplies of unleaded gasoline to meet EPA's lead phasedown requirements in a growing market and to effect needed modernization of facilities to handle high sulfur crude oils. These conditions would lead to reduced competition for unleaded gasoline with a consequent greater price spread between leaded and unleaded regular grades. There could be a tendency to produce less gasoline, leading to a greater dependency on imported sources. In particular, there could be little incentive to increase gasoline production beyond that minimally required, because of the higher costs involved. There would also be an accelerated closing of marginal wholesale and retail outlets within permissible regulations because of shortages.

Some of the comments received, including those of the Federal Trade Commission, supported the discussion in the DEIS that tight gasoline supplies, coupled with the benefits of the small refiner bias, might cause an increase in small refiner gasoline capacity. Because reforming facilities are often impractical or prohibitively expensive for small refiners, increased production of leaded regular gasoline might result, followed by a corresponding increase in the price spread between regular leaded and unleaded grades because of the increased competition for the regular leaded market.

IV B-1d(2) Emission Impacts. The no action alternative, under which refiners would continue as before, is the baseline case against which refinery emissions from the other alternatives will be measured. The primary influence of the various alternatives, as discussed earlier, is the increased investment in reforming capacity, and, therefore, emissions from incremental reforming operations, beginning in 1979-1980 and extending into future years.

IV B-2 Exemption From Controls

IV B-2a Price and Price Differential Impacts

Under complete deregulation, the industry would be free to raise prices subject only to market conditions. As discussed in Section IV A, the total expected price increase under the deregulation alternative is:

Product Costs	3.0 cents
Nonproduct Costs	3.6 cents (spread over the gasoline pool)
Adjustments for Prior Cost Increases	1.6 cents
Dealer Margins	0.6 cents
TOTAL	12.8 cents

In section IV A-3 it was pointed out that the price differential can be expected to increase under the deregulation alternative to about 5.7 cents per gallon by 1980. However, as explained in that section, it could possibly increase to more than 7 cents per gallon if the price differential begins to increase at the rate the refiner differential has been increasing. Therefore, while it is considered a less likely case, the subsequent analysis will assume a price differential of about 8 cents.

IV B-2b Vehicular Emission Impacts

Using data previously presented, national light duty vehicular emissions for the alternative of deregulation become:

TOTAL NATIONAL LIGHT DUTY VEHICLE
EMISSIONS UNDER DEREGULATION ALTERNATIVE IN 1980
(in Millions of Metric Tons)

	Best Case	Expected Case	Worst Case
Hydrocarbons	4.60	4.84	4.97
Carbon Monoxide	57.8	58.8	59.8

Thus, the incremental emissions impact from exemption compared to no action would be, in the expected case, 0.07 MMTm per year for hydrocarbons and 0.4 MMTm per year for carbon monoxide. In the worst case, hydrocarbons would increase 0.14 MMTm per year and carbon monoxide would increase 0.8 MMTm per year, which are 1 percent increases of light duty vehicle emissions.

It needs to be stressed that the forces which tend to create uncertainty on the high or low side for the deregulation case (primarily the fuel switching probabilities) also tend to create uncertainty in the same direction for continued regulation and the other alternatives. Thus, it is appropriate to compare best, expected and worst cases under each alternative, but not, for example, the best case under one alternative to the worst case under another.

The local air quality agencies in three problem cities examined for localized impacts (Washington, Los Angeles, and Denver) all still claim to be anticipating attainment of National Ambient Air Quality Standards (NAAQS) after 1982, as the vehicle fleet becomes progressively cleaner. The impact of increased emissions, then, can be measured by both the increase in ambient concentrations and the delay in time of attainment of the NAAQS.

Appendix D details the development of ambient air concentrations expected in the three urban areas. As discussed there, the control of hydrocarbons, for which there is no NAAQS *per se*, is necessary in order to reduce the atmospheric production of photochemical oxidants, for which there is a standard. Thus, the impact study for urban areas addresses the generation of oxidants directly. By applying the national average price differential, fuel switching rates and individual vehicle emission data to the known vehicle and emission profiles for each of the three urban areas, it is possible in each case to estimate the extent to which attainment of the NAAQS in each of these areas will be delayed. The estimated expected and worst case impacts in these three cities is as follows:

ESTIMATED DELAYS IN ATTAINMENT OF NATIONAL AMBIENT AIR QUALITY STANDARDS IN SELECTED CITIES UNDER DEREGULATION ALTERNATIVE

City	Standards		Impacts		Attainment Delay	
	CO(ppm)	Oxidant(ppm)	CO(ppm)	Oxidant(ppm)	CO(yrs)	Oxidant (yrs)
			Expected Case			
Washington	9.0	.10	.07	.001	.1	.05
Los Angeles	9.0	.10	.14	.001	.05	.05
Denver	9.0	.10	.12	.005	.1	.05
			Worst Case			
Washington	9.0	.10	.14	.002	.2	.1
Los Angeles	9.0	.10	.27	.002	.1	.1
Denver	9.0	.10	.21	.010	.2	.1

The foregoing analysis proceeds from the assumption that the price differentials and fuel switching rates in each of these urban areas are equal to national average figures. There is no data available on the actual fuel switching rates in each of these areas. There is some present average price differential data available for each of the urban areas in question, although DOE cannot vouch for their statistical reliability (as it can for the present national average figure). Data on price differentials obtained from the Bureau of Labor Statistics for the Washington and Los Angeles-Long Beach standard metropolitan statistical areas (which do not coincide precisely with the airsheds on which emissions data are developed), and from Platt's Oilgram for the Denver area (which also likely does not coincide with the area for which emissions data are developed), for the first six months of 1978 show the average differentials to have been as follows:

Washington	4.8 cents
Los Angeles	4.6 cents
Denver	3.7 cents

Thus, available data show that for Washington and Los Angeles actual price differentials may have been somewhat higher than the 4.4 cents per gallon national average used in this analysis, and for Denver it was less than the average. The differences are so small, however, that they do not affect the emissions impact analysis, since an estimate of 1980 differentials in these three urban areas (with the possible exception of Denver) using present local differentials as a base could still be in the 7-to-9 cent range but would not be as high as 10 cents.

As indicated in Section IV A-3, a supply shortage of about 319,000 B/D in 1980, which is not expected but is possible, might result in the leaded/unleaded price differential increasing to 10 cents, in which case a higher level of impacts would be shown because of the higher fuel switching rate.* The increase light duty vehicle emissions that would result from a 10 cent or more price differential would be as follows:

TOTAL NATIONAL LIGHT DUTY VEHICLE
EMISSIONS UNDER DEREGULATION ALTERNATIVE
IN 1980, ASSUMING A SUBSTANTIAL
SUPPLY SHORTFALL
(in Millions of Metric Tons)

	Expected Case
Hydrocarbons	4.91
Carbon Monoxide	59.5

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* As noted in section IV A-3, the size of a supply shortage that would cause an increase in the differential to 10 cents could range from 77,000 B/D to 907,000 B/D, depending upon the shift-to-unleaded factor assumed. We believe a mid-point shift factor of 111% is a reasonable estimate. It is the factor that yields the 319,000 B/D shortfall figure shown.

The impact in the three urban areas considered in this analysis would be approximately as follows:

ESTIMATED DELAYS IN ATTAINMENT OF
NATIONAL AMBIENT AIR QUALITY STANDARDS
IN SELECTED CITIES IF THE LEADED/UNLEADED
PRICE DIFFERENTIAL INCREASES TO 10 CENTS OR MORE

	Impacts		Attainment Delay	
City	CO(ppm)	Oxidant(ppm)	CO(yrs)	Oxidant(yrs)
		Expected Case		
Washington	.19	.002	.33	.14
Los Angeles	.38	.004	.22	.09
Denver	.29	.001	.20	.20

IV B-2c Economic Impacts

Exemption from regulation will have varying impacts on the different sectors of the national economy. It is estimated that gasoline price increases at the retail level will be 12.8 cents per gallon, an increased increment of 3.8 cents per gallon over the base case. (See Table IV A-5.)

The effects on the national economy of a 7 cent per gallon incremental increase in the price of gasoline were evaluated in the September 1977 Report.(III-13) In that analysis a base case solution for the economy was constructed with a motor gasoline price increase of 3 cents per gallon. A second solution for the economy was then constructed assuming a price increase of 10 cents per gallon, or 7 cents per gallon above the base case solution.

An approximation of the effects on selected macroeconomic variables resulting from the estimated incremental increase of 3.8 cents per gallon under deregulation has been derived, assuming a proportional relationship between the 3.8 cent and the 7.0 cent increments (0.5286) as follows:

Indicator	Change	
	7 cents	3.8 cents
Real GNP (billions of 1972 dollars)	-5.2	-2.8
GNP deflator (percentage change)	0.4	0.2
Wholesale price index for fuels (percentage change)	4.6	2.5
Private employment job loss (percentage loss)	0.1	0.05

Because amendments to the present regulation have allowed refiners considerable regional pricing flexibility for gasoline, the FEA estimated interregional variation of impacts were very small when measured in terms of real personal income. The largest impact would be felt in the East North Central region because of the concentration of automobile manufacturing in that area.

In terms of employment effects, the industry facing the largest drop in employment due to decreased demand for its output as a result of lowered national income is the petroleum products industry. This drop would not exceed 1.3 percent.

The effects of fuel substitution, while lessening the total increase in consumer expenditures on gasoline and diminishing the impact of the average price increases, will lead to a faster deterioration of catalytic converters, a consequent increase in pollution, and pollution control costs. While consumer expenditures on gasoline may not rise as fast as with no fuel switching, their maintenance expenditures for the fuel emissions control systems will increase instead, but to an unpredictable degree. In the short run, there will be an additional effect - people who currently own automobiles which do not require unleaded fuel will tend to postpone new car purchases even longer, thus exacerbating the unemployment effects in the auto industry and keeping highly polluting vehicles on the road longer. In the long run, though, this effect will decrease as the older automobiles wear out and need to be replaced. Also, as the percentage of unleaded fuel continues to grow, the price differential may diminish, thus reducing the temptation for fuel switching.*

IV B-2d Petroleum Industry Impacts

IV B-2d(1) Economic Impacts. Under exemption from controls, it is expected that refiners would have an increased incentive to expand their unleaded gasoline manufacturing capabilities and to modernize their facilities to process higher sulfur crude oils. As the demand for unleaded gasoline increases, more refiners would probably market a premium grade of unleaded gasoline to meet the demands of customers who are dissatisfied with engine performance using regular grade unleaded gasoline. This would lead to greater competition for unleaded gasoline markets.

Marketing changes that have been occurring under regulation would be accelerated. The trend toward fewer gasoline stations with higher volume at those remaining would continue. This would tend to reduce or eliminate increases in dealer margins. Alternative strategies would be

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* The Petrochemical Energy Group comments stated that if deregulation causes a loss of BTX petrochemical feedstocks resulting in a sustained 15 percent loss in petrochemical output, 1.6 to 1.8 million jobs and $95-100 billion would be lost to the economy. As noted earlier, the likelihood of such a loss of petrochemical feedstocks is extremely remote.

attempted by the refiner to increase profit margins. There would be an increasing trend to reduce sales territories relative to refinery location. Some refiners might adopt rack pricing policies (that is, charging all customers on the basis of a single terminal gate price plus any actual transportation costs). Others might increase their direct sales outlets to the consumer.

Special Rule No. 4 would provide protection to independent distributors and retailers during an interim period as refiners shift their marketing territories to areas that can be most economically serviced by their own refineries and distribution centers and to discontinue sales to areas which provide a marginal return or may result in actual losses. This should result in a more efficient distribution system than exists at present.

Other actions that refiners might adopt include charges (1-2 percent of sales) to the retailer for use of credit cards, or the discontinuance of credit cards, and charges for maps and other items presently supplied as a free service.

Under deregulation, price changes are anticipated which would more closely reflect the cost of servicing the consumer. This could lead to wider ranges in retail prices than is permitted under present regulations. Thus, customers in rural and sparsely populated regions that are remote from refining and major distribution centers might be faced with even higher prices than today relative to customers in more densely populated areas. Of course, new suppliers, such as farm co-ops and small refiners utilizing a local crude oil supply, might move into these areas, reducing the impact.

Initially, the price spread between leaded and unleaded regular gasoline might increase, but as the percentage volume of unleaded gasoline increases to more than 50 percent of the total pool, competition to establish a solid share of this market may become more intense, causing some downward pressure on unleaded gasoline prices and reducing the spread between leaded and unleaded gasoline.

IV B-2d(2) Impact of Exemption on Refinery Modification and Expansion. Under deregulation there would likely be a positive but non-quantifiable impact on gasoline quality. Under price regulation, refiners have been restricted on the recovery of a return on capital investments needed to meet the continually increasing requirements for unleaded gasoline and higher clear pool octane numbers due to the phasedown in lead additives and the banning of MMT.

The fact that a substantial percentage of the owners of cars using unleaded fuels are dissatisfied with present performance indicates a sizeable market for higher octane unleaded gasolines. While additional refining, and consequent higher energy consumption, would be required to increase unleaded gasoline octane numbers, some, if not all, of this energy could be recovered by improved car performance through better tuning and the production of higher performance engines by the motor vehicle manufacturers which are needed to meet mandated increases in efficiencies.

Many refiners and distributors also would like to offer a higher octane unleaded fuel which could be sold at a premium to offset potential declines in the total gasoline sales resulting from increased prices. In addition, the fact that total gasoline consumption is anticipated to increase only marginally over the next several years will require refiners to increase the value of their products, if they are to maintain satisfactory returns on present investment and earn a desired return on new capital investments.

Under deregulation, it is anticipated that other refiners would follow Amoco's, Shell's and Mobil's announced intention to market an unleaded premium fuel. The introduction of a premium unleaded fuel would eliminate most of the misfueling that presently occurs because of perceived or actual poor performance of present unleaded fuels. It would also provide dealers with another high margin grade (as leaded premium has been for years), which could encourage reduction in regular unleaded gasoline prices to match regular leaded gasoline prices.

The time lag involved in the planning and construction of new facilities means that the benefits resulting from an improved investment climate will not be felt until 1981, and before then the impact of deregulation will be limited to "debottlenecking" existing equipment and changes in operating practices to increase octane ratings. However, under exemption, the perceived need to provide a premium grade unleaded fuel to meet competition and the opportunity for full recovery of capital costs on new or modified facilities, if market conditions permit, should result in an acceleration of the schedule by many refiners to expand capabilities for producing high octane unleaded motor gasoline.

The announced new catalytic reforming capacity schedule for completion in 1980 is only 24,000 B/D compared with 190,000 B/D scheduled for completion in 1979. It is not possible to determine the amount of new or modified catalytic reforming capacity that might be in operation by the end of 1980 because of the time lags involved, but it is reasonable to assume that an additional 75,000 to 150,000 B/D of unleaded gasoline might be available by the end of 1980 or early 1981 compared with quantities anticipated under continued regulation.

The potential growth in demand for premium unleaded gasoline is uncertain. At the present time, the demand for leaded premium grade gasoline is slightly more than 10 percent of the total gasoline demand and is projected to decline to only 1.5 percent of the total demand by 1985. At that level, only a small minority of service stations would continue to provide such gasoline. Thus, availability of adequate high-octane fuel to service pre-1972, high-compression engines is dependent on the development of a market for unleaded premium motor gasoline. Assuming that from 5 to 10 percent of the total market by 1985 will be for premium grade gasoline (a figure supported by some of the commenters), the production of premium grade unleaded fuel will range from 365,000 B/D to 730,000 B/D, and may be higher depending on automotive needs.

Assuming that all additional processing consists of reforming, the extra pollutants generated by petroleum refinery processing of an additional 75,000 to 150,000 B/D can be estimated as follows:

Particulates	767 to 1,533 Metric tons/year
Sulfur oxides (maximum)*	6,150 to 12,300 Metric tons/year
Hydrocarbons	128 to 256 Metric tons/year
Nitrogen oxides	2,646 to 5,293 Metric tons/year

* Assuming fuel gas not desulfurized

If the additional still runs required to make up the feedstock loss in the reformer are also considered, the total emissions would be:

Particulates	803	to	1,606	Metric tons/year
Sulfur oxides (maximum)*	6,442	to	12,885	Metric tons/year
Hydrocarbons	132	to	264	Metric tons/year
Nitrogen oxides	2,774	to	5,548	Metric tons/year

* Assuming fuel gas not desulfurized

It is estimated that 7 percent of this increased capacity would be developed in Los Angeles. The Houston area should have about 10 percent of the increased capacity. With 150,000 B/D increased capacity, operating at 100 percent, the emission impacts in those cities could be (in metric tons/year):

	Los Angeles Impact	1972 Total Emissions	Houston Impact	1972 Total Emissions
Particulate	112	674,000	161	96,000
SO_x	902	216,000	1289	168,000
NO_x	18	1,087,000	26	305,000
Hydrocarbons	388	1,054,000	555	590,000

The largest impact is that of sulfur oxides on Houston, where incremental emissions would be less than one half of one percent of total sulfur oxide emissions. The hydrocarbon and CO impacts are insignificant compared to the vehicular emission incremental impacts.

One comment illustrated that neither Los Angeles nor Houston could allow major refinery expansion, as both are NAAQS non-attainment areas, without corresponding or even greater emissions offsets. Further, the new Prevention of Significant Deterioration limitations of the 1977

Clean Air Act Amendments will serve to reduce significant impacts of refinery construction or modification in areas which are not currently non-attainment areas.

IV B-3 Gasoline Tilt Alternative

IV B-3a Price and Price Differential Impacts

For the alternative of gasoline tilt, the estimated price increase is 12.4 cents (Sections IV A-1 and IV A-2). As discussed in Section IV A-3, under the gasoline tilt alternative, the price differential is expected to be approximately 5.6 cents per gallon. However, as explained there, it could possibly increase to an amount in excess of 7 cents per gallon. Although that is not considered a likely case, the subsequent analysis will assume a 8-cent price differential.

IV B-3b Vehicular Emission Impacts

Assuming a 8-cent price differential, under the tilt alternative the vehicular emissions impacts would be identical to those of the deregulation alternative discussed in the preceding section. However, the discussion in Section IV B-2b regarding the emissions impact if there were a supply shortfall sufficient to increase the price differential to 10 cents does not hold true for the gasoline tilt alternative. As noted in Section IV A-3, a non-cost justified price increase of more than double the total amount of cost justified price increase estimated for this alternative would be necessary in order to increase the differential to 10 cents. A non-cost justified price increase of this magnitude would not be possible under the gasoline tilt alternative.

IV B-3c Economic Impact

The estimated price impact of 12.4 cents per gallon from the tilt in 1980 is 3.4 cents per gallon higher than the base case of no action.

The effects of this level of price increase, compared to no action can be derived from Column 2 in Table IV C-4 by interpolation (3.4 divided by 3.7 x 26) amounting to about $24 per average household. As this would indicate, impacts on households of various disposable income ranges would vary from $16 at the low income levels to $36 at the higher levels.

Estimates of macroeconomic impacts were derived using the same technique as in Section IV B-3, by assuming a proportional relationship between 3.4 and 7.0 cent increments (0.4857) as follows:

Indicator	1979
Real GNP (billions of 1972 dollars)	-2.5
GNP deflator (percent change)	0.19
Wholesale price index for fuels (percent change)	2.2
Private employment job loss (percent)	0.05

Negative impacts on employment can similarly be derived from Table IV C-3 by subtracting Column 1 from Column 2. As this shows, the percentage change would be the most significant for the petroleum products industry as decreased demand for its output is caused by lowered national income. This drop is on the order of 1.2 percent.

IV B-3d Petroleum Industry Impacts

IV B-3d(1) Economic Impacts. The gasoline tilt alternative is similar to the deregulation alternative in that most of the recovery of the costs of increasing supplies of unleaded gasoline and refinery modernization would be possible within the allowable price increases, although the analysis estimates some chilling effect on increased investments because of the continuation of regulations. Under this alternative, there would be some increased incentive to produce unleaded gasoline and to modernize facilities, however, thereby reducing dependency on gasoline imports. Increased price spreads between regular leaded and unleaded grades might develop, but, with growth in unleaded gasoline supplies and the development of premium unleaded gasoline markets, increased competition for regular unleaded gasoline markets is anticipated.

The major difference from deregulation is in the continuing enforcement of the allocation regulations. Major shifts in marketing strategies would be restricted, lengthening the time frame for changes in distribution methods and territories, but mitigating possible adverse impacts on present distributors and dealers. Any potential gains to the consumer from improved efficiencies in distribution costs would be postponed.

Equally important, the enactment of this rule might reduce competition relative to deregulation, because the gasoline tilt rule would continue the feature of the present regulations that cost reductions as well as increases must be reflected in the maximum allowable prices that can be charged. Stated differently, under present rules and under the tilt, refiners would have little incentive to implement efficiencies that would reduce costs.

IV B-3d(2) Environmental Impacts. The incremental refinery environmental impact for the gasoline tilt alternative is similar to that under the deregulation alternative, which is discussed above. The impacts will be somewhat less than under deregulation, assuming under the tilt there is some chilling effect on investments in refinery expansions that delays some investment until 1981. The exact amount by which increased emissions will be less under this alternative than under deregulation is entirely speculative, but it is not expected that the difference will be large.

IV B-4 Price Differential Regulation Alternative

IV B-4a Price and Price Differential Impacts

The expected average gasoline price increase would be the same as under the deregulation alternative. However, the price differentials would be less than under any of the other alternatives, including no action, because the differentials themselves would be regulated at 0 cents and 3 cents per gallon.

IV B-4b Vehicular Emission Impacts

The controlled 3 cent differential can be examined using the previously developed misfueling data. Since those data do not extend to a 0 cent price differential, that case cannot be examined quantitatively.

The national light duty vehicular emissions for a 3 cent differential are:

	Best Case	Worst Case	Expected Case
Hydrocarbons	4.59	4.69	4.64
Carbon Monoxide	57.7	58.2	57.9

The emissions impact from deregulation with a 3 cent maximum differential, compared to the no action alternative, is essentially zero.

At a 0 cents price differential, emissions resulting from misfueling can be expected to be smaller than the 3 cent differential and the no action cases, since there would be no economic incentive to misfuel. Thus, some small environmental improvement could be expected.

Since emissions impacts are essentially unchanged under the 3 cent differential case and are not determinable under the 0 cent case (but would likely be favorable), there would be no delays in attainment of NAAQS, and in the latter case there might even be some slight improvement in the attainment date.*

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* It is possible, as suggested by the Justice Department, that there would be instant adverse effects. The artificial increases in leaded prices which would follow may distort the market to produce unleaded shortages, which in turn would create an adverse emissions impact.

IV B-4c Economic Impacts

For the controlled differential options, the gross economic impact is similar to that of deregulation. However, the enforced differential would be beneficial to owners of unleaded vehicles, the newer vehicles, and would penalize the owners of older vehicles which can use leaded fuel. This is because, in order for retail dealers to maintain the same income, any lowering of the price of unleaded gasoline to comply with the differential limitation would have to be accompanied by an increase in the price of leaded regular fuel. These options might also eliminate dealer competition on leaded gasoline. The FTC comments indicated that the regulations might result in marketing strategies to increase sales of leaded gasoline, such as through elimination of self-service pumps for unleaded gasoline.

IV B-4d Petroleum Industry Impacts

IV B-4d(1) Economic Impacts. Under the zero price differential option, dealers would have to sell unleaded gasoline at the same price as leaded. Since unleaded has a higher cost than leaded, dealers would be forced to sell unleaded gasoline at a loss relative to an uncontrolled market, the loss being made up by an increase in the price of leaded regular. The change in relative prices would serve to increase the use of newer, cleaner, and higher fuel economy cars relative to older cars. In addition, misfueling for price would be eliminated.

The zero price differential option (or any option that holds the differential to less than the difference in costs to refine and market leaded and unleaded gasoline) would, however, require dealers and possibly refiners to price in a way that does not truly reflect their costs. If all suppliers have the same requirement imposed upon them, there should be relatively equal flexibility among firms to shift the extra costs associated with unleaded gasoline to leaded gasoline and no resulting disincentives to refine or market unleaded gasoline. However, since the regulation could impact different firms differently and give certain firms a competitive advantage over others (because, for example, they sell a small proportion of unleaded gasoline), these firms without a competitive advantage would perhaps have a disincentive to produce and sell unleaded, particularly premium grade unleaded, gasoline. Therefore, the 0 cent differential option might have an adverse impact on the supply of unleaded gasoline.

The three cent differential is approximately the same as the present average differential between leaded and unleaded gasoline at the refinery level and is also about equal to the differences in costs of refining leaded and unleaded gasoline. Enforcing this same differential at the dealer level would either reduce present margins for regular leaded gasoline or require higher prices for regular leaded gasoline. It is anticipated that margins for regular leaded gasoline would increase to offset any decline in the margins for regular unleaded gasoline, and would have to increase in higher absolute amounts per unit as the proportion of unleaded gasoline exceeds the proportion of leaded gasoline.

Under both price differential options, some decline in the number of refiners, distributors and dealers would probably occur, reducing competition and increasing prices to the consumer.

IV B-4d(2) Environmental Impacts. The incremental environmental impacts at the refinery level for the regulated price differential alternative can be expected to be approximately the same as for the deregulation alternative.

IV B-5 Regulated Retail Unleaded Margin Alternative

IV B-5a Price and Price Differential Impacts

For the alternative of a maximum price on unleaded regular gasoline, the expected price increase would be approximately the same as for the deregulation alternative, or 12.8 cents per gallon, as explained in Section IV A. As discussed in Section IV A-3, the price differential is expected to increase to about 5.7 cents, as is the case with deregulation, but could increase to 8 cents, which forms the basis for the following analysis.

Regulation effectiveness and enforcement would be expected for perhaps 50 percent of the Nation's sales, as these would be optional by state. In those states which do not choose to make the regulation effective, full deregulation would prevail.

IV B-5b Vehicular Emission Impacts

The vehicular emission impacts for this alternative would be identical to those for the gasoline tilt alternative, as explained in Section IV B-3b.

IV B-5c Economic Impacts

The economic impacts of this alternative would not be significantly different from those of the deregulation alternative.

IV B-5d Petroleum Industry Impacts

The refinery economic and environmental impacts are similar to those of the deregulation alternative.

IV C Social Impacts

IV C-1 Issues

There is not a one-to-one correspondence between the regulatory alternatives as presented and the responses of the driving public. The technical and institutional mechanism designed to facilitate introduction of catalyst-equipped vehicles and the requirement for unleaded gasoline have placed the motorist in a dilemma with respect to regulatory, environmental, performance and price aspects of the simple act of purchasing gasoline.

A popular view is developing that motorists are somehow the victims of a very complex set of circumstances. The Wall Street Journal recently observed that ". . . mismatch between car and gasoline is provoking a growing controversy among auto makers, oil producers and government regulators. Trapped in the middle, helpless car owners are being forced to find their own remedies; most of these remedies are costing the drivers extra money and run counter to national energy-saving goals. . ." (September 26, 1978).

The differential in price and performance between leaded and unleaded gasoline has resulted in what has come to be known as a "social trap": a situation where an individual receives immediate benefit or advantage for doing something that is collectively damaging to the public as a whole. Individuals can receive benefits in quality of vehicle performance and at a lower cost when they misfuel their vehicles. But environmental degradation for all also occurs.

There is evidence from the Sobotka survey (III-II) (discussed in Section III C of this DEIS) that fuel switchers tend to be sophisticated purchasers: the relatively young, middle income, educated portion of the motoring public. It is also this segment of the population which is likely to perceive regulatory policies to be functioning at cross-purposes.

If the individual motorist remains trapped at the environment-energy interface, the result can be generalized dissatisfaction with government in its regulatory role, with the petroleum industry over pricing and product decisions, and with automobile manufacturers over performance problems of vehicles. Other factors are related: inflation, economic stability, and public perception of governmental intervention.

IV C-2 Economic Impacts of Alternatives

Economic impacts considered,* to the extent they can be estimated, given available data, are:

- National economic effects as reflected by the Gross National Product and The Wholesale and Consumer Price Indices.
- Regional effects as indicated by impact on real personal income by region of the country.
- Employment effects by industrial type.
- Personal income effects by class of income.

* Data reported in this section are adapted from Federal Energy Administration, Office of Regulatory Programs, "Findings and Views Concerning the Exemption of Motor Gasoline from the Mandatory Petroleum Allocation and Price Regulations," September, 1977. (III-13)

The impact on the national economy that could result from different hypothetical increases in the price of motor gasoline was evaluated by using the FEA energy models. (DRI Quarterly Econometric Model.) A base case solution for the economy was constructed using a motor gasoline price increase of 3 cents. A second "test" solution for the economy was then constructed in which it was assumed that the motor gasoline price increased by 10 cents per gallon, or 7 cents per gallon above the base case solution for 1979. The proportional relationships between 7 cents per gallon and the estimated price increases under deregulation and under tilt have been used to evaluate the potential impacts on selected macroeconomic variables.

The base case was constructed by first solving FEA energy models to determine values of selected energy variables under base case assumptions. Values for corresponding variables in the DRI-generated solution for the economy were then modified to agree with those generated by the FEA models. These variables are: the wholesale price index for fuels, related products and power; the 1967 dollar value of imported fuels and lubricants; the average unit value index for imported fuels and lubricants; and the implicit price deflator for consumption of gasoline and oil. The DRI model was then solved using these values, to give the base case for the national economy.

The case was constructed by modifying wholesale price indices for refined petroleum products as used in the FEA models. Values generated for the relevant energy variables were then incorporated as revised assumptions to the DRI model base case. A new solution for the economy was generated and compared to that for the base case to determine the effects of the assumed price increase.

IV C-2a Results

The effects on selected macroeconomic variables of a 7-cent-per-gallon incremental increase in the price of gasoline are summarized in Table IV C-1. Unemployment levels on the average are affected by up to 100,000 individuals during any given quarter, for 1979. There is not more than a 0.6 percent increase in the Consumer Price Index or a 0.5 percent increase in the GNP price deflator in any quarter through the end of 1979. The increase in the average wholesale price of energy does not exceed 4.6 percent during any quarter, and real GNP is lowered by no more than of 0.4 percent during these quarters. In dollar terms, real GNP is $5.2 billion lower for 1979 than it is in the base case for that year.

IV C-3 Regional Income Effects

Disparities in regional impacts resulting from hypothetical increases in the price of motor gasoline are measured in terms of real personal income and by census region by comparing projected income levels for the base case with the "test" case.

IV C-3a Methodology

Real personal income for each state is derived by using the Data Resources Inc. State and Area Forecasting System (SAFS). In this model, personal income for each state is a function of 1972 levels of state wage and non-wage income and industrial employment, and projected levels of national wage and non-wage income and industrial employment. Variables

TABLE IV C-1. EFFECTS OF $0.07 PER GALLON INCREMENTAL INCREASE IN PRICE OF GASOLINE

		Quarterly				Annual
		1979:I	1979:II	1979:III	1979:IV	1979
Real GNP (1972 Dollars)	Change in Annual Rate--billions	-9.2	-1.7	-4.9	-5.1	-5.2
	Percent Change	-0.6	-0.1	-0.3	-0.3	-0.4
Nominal GNP	Change in Annual Rate--billions	-7.6	6.6	2.6	3.0	1.2
	Percent Change	-0.3	0.3	0.1	0.1	0.0
Unemployment	Change in Level (millions)	0.1	0.1	0.1	0.1	0.1
	Percentage Point Difference in Rate	0.1	0.1	0.1	0.1	0.1
GNP Implicit Price Deflator	Percent Change	0.3	0.4	0.4	0.5	0.4
Consumer Price Index	Percent Change	0.5	0.5	0.6	0.6	0.6
Wholesale Price Index for Energy (Fuels, Related Products, and Power)	Percent Change	4.8	4.5	4.6	4.5	4.6

are added to the income and employment equations to adjust for any bias resulting from the fixed-share approach. Income for the census regions is derived by summing appropriate state incomes. Output from the Data Resources Inc. macroeconomic model acts as input into the SAFS model.

IV C-3b Results

Previous amendments to the DOE regulations have already afforded refiners regional pricing flexibility for gasoline up to 3 cents per gallon. Therefore, deregulation should not result in disparate price increases among regions. Differences in regional income levels which might result from increases in the price of gasoline under deregulation and tilt are shown in Table IV C-2. Impacts across regions are minor.

The relatively greater impact on income ($180 million) in the East North Central region in attributable in large part to lower earnings for Michigan, Ohio, and Indiana. A slightly lower national income inherently results in lower demand for automobiles nationwide, which in turn affects the economy in a very select way, because automobile manufacturing is highly concentrated in this region.

In brief, the results show that real personal income levels in any of the nine census regions would be lowered by, at most, $20 million compared with tilt, and $190 million compared with no action. There is little interregional variation of impacts in terms of real personal income.

TABLE IV C-2. IMPACT OF DEREGULATION ON REAL PERSONAL INCOME BY CENSUS REGION, 1979 (billions of 1972 Dollars)

Region	Compared to Tilt (0.4 cents per gallon)	Compared to No Action (3.8 cents per gallon)
New England	0.003	0.03
Middle Atlantic	0.01	0.11
South Atlantic	0.01	0.14
East North Central	0.02	0.19
East South Central	0.01	0.07
West North Central	0.02	0.16
West South Central	0.01	0.14
Mountain	0.005	0.05
Pacific	0.01	0.12
U.S. Total	0.1	1.03

Note: Totals may not add because of rounding

Data Base Source: Ref III-13, Table V-6

IV C-3c Other Regional Effects

Recent regulatory changes also have allowed for certain regional price differentials in recognition of varying regional and sub-regional costs. However, releasing supplies from allocation controls would provide refiners with the opportunity to withdraw from marginal marketing areas or to alter current marketing practices, thus creating the possibility of temporary sub-regional spot shortages. However, these spot shortages and dislocations would exist only as long as required for the market in these areas to stabilize. Thus, the overall impact of the proposed regulatory changes is negligible. However, sub-regional deviations are speculative and no data exist to predict that they would occur. Normally, if there is a demand, some entity will satisfy that demand as long as there is no overall supply shortage. Some predominantly rural states in their comments on the DEIS expressed concern that with the marginal volume of sales and higher marketing costs, suppliers would be less willing to provide services except at higher prices. Several states indicated that state set asides for gasoline and other petroleum products should be retained.

IV C-4 Industry Employment Effects

IV C-4a Methodology

To determine industry impacts attributable to gasoline decontrol, it was first necessary to estimate impacts on components of final demand for nineteen categories of Personal Consumption Expenditures, Gross

Private Domestic Fixed Investment, Business Inventories, Imports, Exports, Federal Defense Expenditures, Federal Non-Defense Expenditures, and State and Local Government Expenditures. These were then applied to the input-output bridge program to generate total final demand by input-output classification industry. Employment requirements were estimated for 1979 for deregulation compared with tilt and no action cases. The ten industries having the largest measurable percentage changes in employment requirement are presented in Table IV C-3.

IV C-4b Results

For 1979, the impact of a 3.8 cents per gallon increase in the price of gasoline under deregulation is expected to reduce industry employment in these industries in a range from -0.27 percent in the miscellaneous stone, clay and glass products industry to -1.30 percent in the petroleum products industry. The impact on total private employment as measured by jobs lost is less than 0.1 percent.

IV C-5 Socioeconomic Effects

IV C-5a Methodology

There are direct and indirect effects of any increase in the price of motor gasoline. Direct effects on the consumer would result from an increased price for motor gasoline at retail outlets. Indirect effects would consist principally of increased prices for consumer products which use motor gasoline in the distribution of such products. These indirect

TABLE IV C-3. MAXIMUM NEGATIVE IMPACT ON EMPLOYMENT FOR SELECTED INDUSTRIES OF ASSUMED PRICE INCREASES IN THE PRICE OF GASOLINE (Percentage Change)

Rank	Industry	Compared to Tilt (0.4 Cent per gallon)	Compared to No Action (3.8 cents per gallon)
1	Petroleum Products	-0.13	-1.30
2	Crude Petroleum	-0.11	-1.09
3	Other Transportation	-0.09	-0.85
4	Misc. Transportation Equipment	-0.05	-0.46
5	Motor Vehicles	-0.04	-0.43
6	Water Transportation	-0.04	-0.41
7	Wholesale Trade	-0.04	-0.37
8	Rubber Products	-0.03	-0.29
9	Misc. Nonferrous Metal Products	-0.03	-0.27
10	Misc. Stone Clay, and Glass Products	-0.03	-0.27

Base Data Source: Ref. III-13, Table V-7.

effects are very difficult to estimate, but some idea of their magnitude may be obtained by examining the previous section on industrial impact.

Direct effects are more easily estimated by use of Federal Highway Administration statistics on gasoline consumption in total and by income class.

IV C-5b Results

As can be seen from Table IV C-4, average annual household expenditures for motor gasoline in 1979 would increase by $3 compared with tilt and $26 compared with no action. As would be expected, these increased expenditures, as a percentage of income, are greater for lower income groups than for higher income groups since consumption of motor gasoline does not increase proportionately with income. While the absolute dollar amount under deregulation rises from about $19 per year for the lowest income group to $41 per year for te highest, the impact measured as a percentage of income declines.

IV C-6 Summary and Conclusion--Social Impacts

The effects of a 3.8 cents per gallon incremental increase in price of gasoline on selected macroeconomic variables are not significant and the removal of allocation and price controls will cause virtually no adverse effects at the sub-national level or on the economy as a whole.

TABLE IV C-4. INCREASE IN DIRECT HOUSEHOLD GASOLINE EXPENDITURES BY INCOME CLASS, 1979 (dollars per year)

Household Disposable Income	Compared to Tilt (0.4 cents per gallon)	Compared to No Action (3.8 cents per gallon)
Under $3000	$2	$19
$3000 - $3999	2	22
$4000 - $4999	3	26
$5000 - $5999	3	31
$6000 - $7499	3	31
$7500 - $9999	3	34
$10,000 - $14,999	3	34
$15,000 and over	4	41
National Average	3	27

Base Data Sources: Ref III-13, Table V-4, and U.S. Department of Transportation, Federal Highway Administration Statistics

With these data, it can be calculated that, under deregulation, .6 billion vehicles miles would be incrementally traveled in 1985 with impaired catalysts under the expected case, and 21.7 billion under the worst case. By constrast, in 1980, the vehicle miles traveled with impaired catalysts under the same condition is 1.1 billion and 52.1 billion, respectively. Thus, impacts in 1985 are lower than 1980, and will continue to decline with the attrition of incrementally impaired catalysts.*

As a result of improved investment climate under decontrol, it is estimated that additional higher octane processing capacity of 500,000 B/D might be constructed by 1985. This number is maximum incremental capacity, and is developed from the potential market for premium unleaded gasoline.

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* EPA and the California Air Resources Board contended that our analysis in the DEIS improperly used a linear projection of incremental impacts over time based on current State Implementation Plan (SIP) projections for attainment of the NAAQS's. The criticism was to the effect that the current SIP's in general fail to take into account the adverse impacts of fuel switching, and therefore the attainment time will be longer than we project. We agree that the SIP's tend to understate the base case effect of fuel switching. Our purpose, however, is not to predict when attainment will occur, but only to indicate the delay from whenever attainment would otherwise occur that will be caused by the incremental fuel switching resulting from the actions taken by DOE. We have in fact probably overstated that incremental delay, since it is assumed in our analysis that the vehicle fleet whose catalysts are poisoned as a result of the DOE actions (the 1975-81 model year fleet) will continue to have the same impact in all years through 1987. In fact the vehicle miles driven by this fleet will decline markedly through the 1980's and by 1990 will have virtually no emissions impact.

IV D Future Impacts

Most of the foregoing impact analysis (with the exception of the discussion of impacts on attaining NAAQS in problem cities) was for 1980, a year with impacts expected to be worse than 1979. The question of impacts beyond 1980 has so far not been addressed in detail. Complicating the analysis for future years is the introduction of unleaded premium fuel, with subsequent lower misfueling for performance reasons; the continuing decrease of average per vehicle emissions as older vehicles are retired and new, cleaner vehicles are added; the emergence of unleaded regular gasoline as the dominant grade; and the automatic termination on October 1, 1981 of regulations based on the EPAA.

Incremental vehicular emission impacts in 1985 would be from those vehicles which misfueled prior to termination of regulations in 1981. Thus, the expected and worst case fuel switching rates for model years 1975-1985 would be as follows (in percent):

	Base Case		Increment from Deregulation	
Model Year	Expected	Worst	Expected	Worst
1985	n/a	n/a	n/a	0
1984	n/a	n/a	n/a	0
1983	n/a	n/a	n/a	0
1982	n/a	n/a	n/a	0
1981	0.4	2.7	0.4	8.7
1980	0.6	2.9	0.6	8.9
1979	1.6	4.2	1.7	10.1
1978	4.1	7.4	4.3	13.0
1977	4.1	7.4	4.3	13.0
1976	4.1	7.4	4.3	13.0
1975	4.1	7.4	4.3	13.0

Assuming that all additional processing consists of reforming, the extra pollutants generated by a petroleum refinery processing an additional 500,000 B/D in 1985 can be estimated to be:

Particulates	4,654 metric tons/year
Sulfur oxides (maximum)*	37,247 metric tons/year
Hydrocarbons	776 metric tons/year
Nitrogen oxides	16,093 metric tons/year

If the additional still runs required to make up the feedstock loss in the reformer are also considered, the total emissions would be:

Particulates	4,869 metric tons/year
Sulfur oxides (maximum)*	38,989 metric tons/year
Hydrocarbons	812 metric tons/year
Nitrogen oxides	16,840 metric tons/year

* Assumes fuel gas is not de-sulfurized

As noted earlier, some commenters pointed out that the net incremental emissions would be much smaller because of the effects of the EPA's emissions offset policy and Prevention of Significant Deterioration regulations. They also commented that there would be no significant impact on water quality, solid waste, noise, toxic substances and land use.

IV E Sensitivity Analysis

In this section the sensitivity of the air quality analysis to assumptions is examined. Carbon monoxide is used as a "tracer" of sensitivity because it shows more sensitivity than hydrocarbons. Emissions are used as an impact indicator because of their linear relationship to air quality. Sensitivity analysis is based on the worst case, rather than the expected case, because the larger numbers produced will show the relationships more clearly.

It was shown that, in the worst case (corresponding to 1 percent probability) for deregulation compared to continued regulation, 1980 emissions of carbon monoxide would increase from 59.0 to 59.8 MMTm, an increase of 0.8 MMTm. These numbers are the base case around which sensitivity will be developed.

While the analysis for emissions *per se* is sensitive to the assumptions made, the incremental impact of the various alternatives is relatively insensitive. The reasons for this are:

(1) Much of the light duty vehicular emissions is from vehicles older than model year 1975. These emissions are unaffected by assumptions about misfueling rate.

(2) The assumptions that tend to inflate estimates of impact for the alternatives to no action serve also to inflate estimates of impact for the no action alternative.

IV E-1 Sensitivity to Premium Unleaded

The full scale introduction of a premium unleaded fuel should serve to decrease misfueling for performance after its introduction. For the purpose of examining sensitivity, it is assumed that premium unleaded fuel will be used by 50 percent of all misfueling motorists (an EPA study[III-13] indicates 50 percent switching for performance), and that premium unleaded fuel has been available since 1975. The worst case incremental impact of 0.8 MMTm of CO emissions in 1980 could be reduced to an incremental impact of about 0.6 MMTm with the introduction of a premium unleaded fuel.

IV E-2 Effect of Dealer-to-Dealer Price Differential Variation

It was assumed in the impact analysis that unleaded/leaded regular price differentials at each retail service station would be the same as the projected national average differential under consideration. It was previously demonstrated that the area-average price differential in the three problem cities examined in the analysis was close to the national average. However, it is necessary to consider the sensitivity of the results to the fact that all stations do not have differentials at or near the median, and in fact are widely dispersed on either side of it.

If the dispersion in price differential among various stations is used, instead of average price differential, slightly different results are found. For example, the national worst case hydrocarbon incremental emissions impact for the alternative of deregulation was shown above to be 0.14 MMTm/yr. If the differential in 1980 were 7 cents per gallon and dealers are assumed to be dispersed using the standard deviation among stations of 2.2 cents, as developed in Appendix C, the emissions impact would be only very slightly reduced. If the national average differential in 1980 were 8 cents per gallon, the corresponding impact would be only very slightly increased. Thus, the vehicle emission impacts are not significantly sensitive to assuming that all dealer margins are at the average.

IV E-3 Impact of Gasoline Octane Deficit

If the octane of unleaded gasoline should decrease, or the octane requirement of vehicles increase, the result may be a significant increase in misfueling, depending upon whether misfueling is initiated by price or performance. The impact of the alternatives to no-action are insensitive to this possibility. However, the increased incentive to invest in new facilities of the alternatives compared with no-action should reduce the possibility of this occurrence.

IV F The Effect of Dampened Demand

The actions proposed which would raise the price of gasoline would also dampen demand in accordance with the elasticity of gasoline demand. EIA has estimated that every one-cent increase of gasoline will result in a reduction in demand of 21,000 B/D.

The alternatives to no-action all show a price rise of about 3.4 to 3.8 cents per gallon over no-action, pool average, and thus gasoline consumption should decrease by about 71,000 to 80,000 B/D, or about 1 percent of total expected demand in 1980.

Apportionment of this 1 percent reduction shows a decrease of 0.07 MMB/D in U.S. refinery operation, a decrease of 0.03 MMB/D in petroleum imports, and a decrease of 1 percent in total vehicle miles.

A decrease of 0.07 MMB/D in U.S. refinery operation would result in the following nationwide decreases in emissions from petroleum refining:

Table IV F-1 summarizes the changes due to price elasticity.

Table IV F-1. REDUCED EMISSIONS AS A RESULT OF REDUCED GASOLINE DEMAND

Refinery Production	- .07 MMB/D
Petroleum Imports	- .03 MMB/D
Air Emissions	
Particulates	- .01 MMTm/yr
Sulfur oxides	- .06 MMTm/yr
Hydrocarbons	- .15 MMTm/yr
Nitrogen oxides	- .09 MMTm/yr
Carbon monoxide	- .86 MMTm/yr
Oil Spills	- 290 B/yr

The reductions for hydrocarbons (.15 MMTm/yr) and carbon monoxide (.86 MMTm/yr) would more than offset the expected incremental impacts from deregulation under both the expected and worst cases (hydrocarbons of .07 MMTm/yr and CO of .4 MMTm/yr in the expected case; hydrocarbons of .14 MMTm/yr and carbon monoxide of .8 MMTm/yr in the worst case).

The price increase under the gasoline tilt alternative compared to no-action is 3.4 cents, which would dampen demand by about 71,000 B/D, or about 90 percent of the amount under the other alternatives to no-action. Under the gasoline tilt alternative, therefore, it can be expected that the offsetting reduction in impacts shown above would be reduced by a similar proportion.

IV G Other Impacts

Other impacts not otherwise explicitly considered are discussed below:

Water - None of the effects of the alternative were seen to have an impact on water, except oil spills, which are insignificant and would likely be offset by the effect of reduced demand. One refiner pointed out that existing rigid standards for effluents serves to prevent adverse water impacts resulting from additional processing equipment.

Solid Waste - The offsets of the alternatives were not seen to have an impact on solid waste.

Land Use - Induced refinery capacity will be growth in place; no incremental land use is seen as a result of any alternative.

IV H Impact Summary

The estimated incremental impacts of the various alternatives have been set forth in the preceding text. This section is presented to summarize these impacts.

IV H-1 Gasoline Prices and Price Differential Impacts

The analyses for expected price increases at the refiner and retail dealer levels are presented in Sections IV A-1 and IV A-2, respectively.

A summary of price increases expected through 1980, and incremental price increase, is presented in Table IV H-1.

Table IV H-2 documents the economic impact of the alternative on a typical family in 1980.

Table IV H-3 documents expected and potential retail price differentials between leaded and unleaded gasoline for the alternatives in 1980.

TABLE IV H-1. COMPARISONS OF EXPECTED 1980 GASOLINE PRICE INCREASES FOR THE VARIOUS ALTERNATIVES (Cents Per Gallon)

Alternative	Refiner	Retail Dealer	Total
No Action	8.8	0.2	9.0
Gasoline Tilt	12.2	0.2	12.4
Deregulation	12.2	0.6	12.8
Regulated Price Differential	12.2	0.6	12.8
Regulated Unleaded Margin	12.2	0.6	12.8

INCREMENTAL PRICES COMPARISON (Cents Per Gallon)

Alternative	Compared to No-Action	Compared to Tilt
Gasoline Tilt	3.4	---
Deregulation	3.8	0.4
Regulated Price Differential	3.8	0.4
Regulated Unleaded Margin	3.8	0.4

TABLE IV H-2. TYPICAL FAMILY ECONOMIC IMPACT

Alternative	No Action	Tilt
Gasoline Tilt	$24.00	-----
Deregulation	$27.00	$3.00
Regulated Price Differential	$27.00	$3.00
Regulated Unleaded Margin	$27.00	$3.00

TABLE IV H-3. EXPECTED RETAIL PRICE DIFFERENTIALS IN 1980 UNDER EACH ALTERNATIVE (Cents Per Gallon)

Alternative	Expected Retail Price Differential (105% Shift Factor)	Maximum Potential Retail Price Differential (117% Shift Factor)
No Action	5.3	7.5
Tilt	5.64	8.6
Deregulation	5.68	8.8
Regulated Price Differential	(a)	(a)
Regulated Unleaded Margin	5.68	8.8

(a) Regulated at 0 or 3 cents per gallon.

IV H-2 Environmental Impacts

The incremental national light-duty vehicle emission impacts from the deregulation, gasoline tilt and regulated unleaded margin alternatives, compared to the no-action alternative, are summarized in Table IV H-4.

TABLE IV H-4. NATIONAL LIGHT DUTY VEHICLE EMISSIONS IMPACTS (MMTm/yr)

Alternative	Expected Case		Worst Case	
	CO	HC	CO	HC
Tilt and Rent Passthrough	0.4	0.07	0.8	0.14
Deregulation	0.4	0.07	0.8	0.14
Regulated Price Differential	- 0.25	-0.05	-0.5	-0.10
Regulated Unleaded Margin	0.4	0.07	0.8	0.14

These must be compared to national anthropogenic emissions of 28 MMTm/yr for hydrocarbons, and 87.5 MMTm/yr for CO.

These national impacts would be offset entirely by the reduced CO and hydrocarbon emissions resulting from the dampening effect on demand of price increases expected under deregulation and regulated unleaded margins. The offsetting effects are shown in Table IV H-5.

TABLE IV H-5. OFFSETTING EFFECT OF REDUCED DEMAND ON EXPECTED AND WORST CASE VEHICLE EMISSIONS (MMTm/yr)

	Expected Case Incremental Emissions	Worst Case Incremental Emissions	Emissions Offset From Reduced Demand
Hydrocarbons	0.07	0.14	.15
Carbon Monoxide	0.4	0.8	.86

If the offsetting effect of reduced demand is disregarded (or is minimal in specific localities), the national air quality impacts can be translated into effects on certain cities expected to have difficulty in meeting National Ambient Air Quality Standards in the 1980's. Table IV H-6 shows the impacts resulting from the deregulation, gasoline tilt and regulated unleaded dealer margin alternatives, compared to no-action.

TABLE IV H-6. IMPACT ON SELECTED CITIES

	Washington, D.C.	Los Angeles	Denver
Expected Oxidant Increment	.001 ppm	.001 ppm	0.0005 ppm
Maximum Oxidant Increment	0.002 ppm	0.002 ppm	0.001 ppm
Expected Attainment Delay	0.05 yrs	0.05 yr	0.05 yr
Worst Case Attainment Delay	0.1 yr	0.1 yr	0.1 yr
Expected CO Increment	0.07 ppm	0.14 ppm	0.12 ppm
Maximum CO Increment	0.14 ppm	0.27 ppm	0.21 ppm
Expected Attainment Delay	.1 yr	.05 yr	.1 yr
Worst Case Attainment Delay	.2 yr	.1 yr	.2 yr

Expected incremental impacts from refinery expansions, although calculated from a generous estimate of induced refinery expansions, produced emissions increases of less than one-half of one percent of baseline in the selected cities of Los Angeles and Houston.

IV H-3 Sensitivity

The sensitivity of the impact study was examined, and it was shown that the incremental impacts were not very sensitive to the stated assumptions that:

(1) There would be no significant emergence of a premium unleaded fuel

(2) All retail stations have price differentials at the median differential under consideration.

Further, the incremental impacts were, in the worst case, not significantly changed for 1985 as compared to 1980.

V MEASURES AVAILABLE TO MITIGATE IMPACTS

The preceding chapter has explored the potential impacts which could result from the various alternatives. The purpose of this chapter is to explain a series of actions open to the Federal Government which could serve to forestall or limit the severity of the potential impacts from the proposed actions. Because DOE is only one of several Federal entities which have authority to regulate gasoline marketing, a full discussion of mitigating measures must include actions available to other regulatory agencies.

V A Potential Mitigating Measures Available to DOE

V A1 Restoration of Pricing and Allocation Controls

As mentioned earlier, the Emergency Petroleum Allocation Act provides DOE with the authority to reimpose controls on motor gasoline through September of 1981. Thus, if the deregulation alternative is adopted, this authority, provided by Congress with the specific purpose of limiting the economic dislocations that would be inherent in a gasoline shortage, could be exercised if a shortage arises in the future.

Present DOE projections of supply and demand for 1980 indicate that refiners may have to strain their refinery capacity in order to meet demand (see Chapter III, Section B). Under these conditions the market is more vulnerable to supply interruptions, and a shortfall situation becomes a possibility. In such a shortage situation, the price differential between leaded and unleaded gasoline could change significantly as discussed in Chapter IV, Section A-3.

Reimposition of controls would likely be accomplished in accordance with the Standby Petroleum Price and Allocation Regulations recently adopted by ERA. Those regulations authorize the Administrator of ERA to reimpose controls at any time a fuel emergency exists. In most cases, DOE would likely hold a hearing and receive public comment before activating the standby regulations. But, if the circumstances are such that failure to reimpose controls immediately would result in serious harm or injury to the public health, safety, or welfare, they could be imposed before public comment is obtained. The standby regulations give the Administrator discretion to adopt controls on all levels of the industry as they exist now, or to adopt them only for specific levels and specific grades of gasoline.

Environmental impacts due to fuel switching would thus be limited to those caused by vehicles which fuel switched prior to the reestablishment of controls. Because the catalytic converters on these vehicles would be permanently impaired, their increased emissions will continue after controls had been reimposed.

In Chapter IV, it was pointed out that a 319,000 B/D supply shortfall in 1980 under deregulation could result in a 10 cent price differential between leaded and unleaded gasoline. At such a differential, it was estimated that incremental vehicle emission impacts for carbon monoxide, for example, increase to 1.1 MMTm under expected case assumptions.

A-2 Collection of Information Regarding Impacts

DOE has initiated a system of receiving and analyzing information regarding both gasoline prices at retail levels (including leaded/unleaded differentials) and the relative market shares of different segments of the industry. DOE has also undertaken a data collection and analysis system to ascertain price differential levels at full-serve and self-serve retail outlets on a geographic and national basis.

DOE will publish its findings periodically. If deregulation is adopted, these findings will address the national and geographic trends in price differentials and assess the current situation with respect to fuel switching, including results of EPA studies and enforcement activities.

If at any time DOE determines that significant environmental impacts are occurring or are likely to occur as a result of actions taken by DOE with respect to achieving the objectives of deregulation, DOE will propose appropriate regulatory or other action which would have the effect of mitigating these impacts.

V A-3 Enforcement of Price Posting Regulations

Current DOE regulations require the posting of maximum lawful gasoline price and octane information on each retail pump.* Vigorous enforcement by DOE of at least the price posting aspect of this regulation has been suggested as a measure which could mitigate excessive unleaded gasoline prices that stem from pricing violations.

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* In 1978 Congress authorized the Federal Trade Commission in the Petroleum Marketing Practices Act to require octane posting on retail pumps. When the FTC's authority is implemented by regulations, which are expected to be promulgated in April 1979, DOE will repeal its own redundant octane posting requirement.

Because such a measure is relevant only in a controlled market, it would be considered only under the alternatives of gasoline tilt, no action, regulated price differential and regulated unleaded margin.

V A-4 Reimposition of the State Set-Aside Program

The State Set-Aside Program is one facet of the current regulatory scheme which will lapse if motor gasoline is decontrolled. The program requires prime suppliers to make available, if requested, a specified small percentage of the total volume sold into the state for consumption within the State. This volume may be distributed by the State to resolve emergencies and hardships due to fuel shortages.

Special Rule No. 4 was proposed concurrently with deregulation. The rule would help ensure that marketers would have a source of supply for up to one year following deregulation.

Some States, including Vermont and West Virginia, expressed concern in their comments on the DEIS that a period of supply instability may result following the expiration of Special Rule No. 4. To mitigate any hardships which might be experienced due to post-decontrol shifts in supply relationships, DOE could reimpose a program similar to the current State set-aside. Similar action during the past three winters has been taken with regard to middle distillates, a product deregulated in all other aspects.

V A-5 Increased Use of Gasohol

One of the commenters suggested that reforming capacity requirements to produce a higher octane clear gasoline pool could be lessened by the increased use of alcohol as an additive to gasoline. In particular, it was pointed out that a 90/10 blend of unleaded gasoline and alcohol produces a high-performance motor fuel without the need for more refining capacity than is necessary to produce the unleaded gasoline portion of the mixture. This would be a mitigating means of forestalling a serious unleaded gasoline shortage and the adverse environmental effects that might result.

DOE agrees wholeheartedly with the comment that alcohol-based fuels can in the future be useful in stretching gasoline supplies and that increased use of the product should be encouraged. In fact, it has already made certain changes in the current regulations that facilitate the pricing of the product to take into account the current high cost of the alcohol additive and that provide entitlements subsidies to the producers of gasohol. Unfortunately, however, gasohol will not contribute substantially to gasoline supplies in the immediate future because of limited facilities at the present time to produce alcohol in large volumes and the need for greater consumer education and acceptance. (See the comments of Exxon and other refiners on this point.) DOE currently has an alcohol fuels task force that is giving priority attention to these problems.

V B Regulation Requiring Equal Display of Leaded and Unleaded Prices by the FTC

Presently, the "fighting grade" of gasoline is the leaded regular grade. For many retailers, this is the only grade of gasoline for which the price is posted in a manner visible to passing motorists. Many drivers of unleaded only vehicles may pull into a station posting a competitive price for leaded gasoline only to find a wide price differential between leaded and unleaded gasoline. Once in the station, however, many motorists are likely to purchase the unleaded product at a high price, even though they would have done business elsewhere if they had known of the price before entering the station. This result would tend to maintain unleaded prices at levels above what they would be if consumers were provided with complete price information.

The FTC has the authority to impose a trade regulation rule upon gasoline retailers which would require retailers to display unleaded gasoline prices with equal prominence to those of leaded prices. DOE and EPA have urged FTC to utilize this authority in order to enhance price competition in the sales of unleaded gasoline. (Letter from David Bardin, Administrator of ERA, and Barbara Blum, Deputy Administrator of EPA, to Michael Pertschuk, Chairman of the FTC, January 22, 1979) The FTC has asserted, in its comments on the DEIS, that DOE may possess similar authority under the EPAA. As noted in section V A-3, DOE does possess authority to require posting of maximum lawful prices; DOE will review that authority to determine whether it is broad enough to encompass the equal posting mitigation measure.

The equal posting requirement should improve competition in the sales of unleaded gasoline by encouraging dealers to price unleaded with the local competitive market. The price differential between leaded and unleaded gasoline would thus be expected to shrink. The FTC, in its comments on the DEIS, supports the effectiveness of this measure by referencing the Lundberg Letter of July 14, 1978. The Lundberg Letter noted that the incidence of street posting of unleaded prices increased significantly between April 1977 and April 1978 in 10 out of 11 Western markets surveyed. Where street posting occurred, the average price differential shrunk. Stations posting unleaded prices showed price differentials which were 16 percent lower than stations which failed to post unleaded prices.

V C Potential Mitigating Measures Available to the Environmental Protection Agency

V C-1 Encouragement of Vehicle Inspection/Maintenance Program

The Clean Air Act requires each state to submit to EPA a State Implementation Plan (SIP) which assures the attainment of primary and secondary air quality standards. Although the courts have held that EPA may not mandate that states implement inspection/maintenance systems which require motorists to pass yearly emissions tests in order to renew their vehicle registrations, the 1977 Clean Air Act amendments provide for termination of certain Federal funds to areas failing to meet the NAAQS. This provision essentially forces adoption of inspection/maintenance programs in those areas which trace their non-attainment status primarily to mobile source emissions.

Several states (New Jersey and Rhode Island) and numerous cities have implemented idle mode vehicle emissions tests as part of their SIP requirements. Although these "tail-pipe" emissions tests are not as sophisticated as the new motor vehicle emissions tests conducted by EPA, they can be used to identify "gross emitter" vehicles. To the extent that vehicles with defective catalysts can be identified by these programs, they will mitigate the impact of deregulation. More active encouragement of inspection/maintenance would provide a disincentive for motorist fuel switching and dampen the vehicle emission impacts of gasoline deregulation.

The State of New Jersey, in comments on the EIS, expressed enthusiasm about its I/M program, and felt that it alleviated emissions from fuel switching.

V C-2 Tamperproof Filler Inlet Restrictors

EPA has authority under the Clean Air Act to require modifications to new models of motor vehicles in order to minimize vehicular emissions. Current gasoline filler pipe inlets are equipped with restrictors which permit only unleaded gasoline nozzles to enter. These restrictors are generally wedged or bolted into the filler inlet; a reasonably handy person can remove the restrictor without much effort. It has been suggested that misfueling could be decreased by welding the filler inlet restrictors to inlets or simply reducing the size of the inlets.

While this mitigation action might prove effective in the long run, immediate relief would not be provided. The GMC survey (III-9) demonstrated that almost all misfueling occurred in vehicles of at least two years of age. Should restrictor improvement begin today on the 1979 model year, midfueling in 1980 would be virtually unchanged. In fact, it would be 1983 to 1984 before the average misfueling rate in the vehicle fleet rate would be decreased by a factor of two, assuming that restrictor improvement was 100 percent effective. Motorists' nozzle adapters and undersized nozzles on regular pumps would decrease effectiveness to less than 100 percent. In short, this mitigative action is not expected to affect the 1979-1980 results described in this EIS.

Moreover, the Ford Motor Company, in its comments on the DEIS, noted that Ford fillers are already welded in place. Ford also asserted that production of a temperproof filler inlet is virtually impossible because nozzle adapters can always be used. Use of methods other than removal of the filler inlet restriction was shown to be extensive in the Motor Vehicle Tampering Survey (V-1) prepared by EPA (referenced in both the EPA and Center for Auto Safety comments on the draft EIS).

Thus, while production of a filler inlet restricter which is more difficult to defeat may discourage some fuel switchers, the potential success of this measure is speculative and would be useful in the long term only.

V C-3 Motorist Penalty

Currently, there is no federal penalty on a motorist for misfueling. It has been suggested that a fine be placed on a motorist for misfueling an unleaded vehicle.

As in the preceding discussions, the regulatory framework of EPA does not allow the development and enforcement of such a regulation within the 1979-1980 timeframe. There has been an observed reluctance on the part of dealers to risk the current $10,000 fine imposed on them for allowing an unleaded vehicle to be misfueled. Such a reluctance would most likely be manifested in motorists as well, and thus such penalties could be expected to decrease the occurrence of misfueling.

As misfueling is more frequent with older vehicles, the sub-population which would be subject to fines would be the less affluent. Significant effort in public education would be required to reach these motorists.

Finally, as the majority (34) of states in one form or another already prohibit or discourage fuel switching by motorists, it is clear that a similar federal action would provide little further disincentive.

V C-4 More Enforcement Through Dealer Fines

Assessment of the fine against dealers is infrequent. Certainly, neither participant in a misfueling transaction is likely to report the misfueling action to enforcement officers. A program of vigorous enforcement of the regulation could have a measurable effect on decreasing the average misfueling rate.

The adoption of such a program would require continuous enforcement, as catalyst poisoning is an irreversible result of misfueling. With proper funding such a program could be begun immediately, with incremental effects noticeable in 1979-1980.

If fuel switching were reduced 50 percent by such an enforcement program, the impacts would be identical to the case of reduction of fuel switching by 50 percent through the introduction of unleaded premium, addressed in Section IV. It was shown that the worst case incremental impact of deregulation, with enforced dealer fines, would be 0.2 MMTm/yr for CO.

V C-5 Extension of Lead Phasedown

The EIA analysis, supported by independent industry analyses, shows that extension of the lead phasedown waivers beyond October 1, 1979 will extend gasoline supply by about 500 MB/D in 1980. Through the 1980's, the average lead content of the pool declines rapidly as leaded gasoline consumption declines: the phasedown moves up the date at which lead is removed and for the next few years requires that the lead content in leaded gasoline be reduced substantially.

The EPA could, for instance, extend the waivers for those refineries serving areas of the country where ambient air quality concentrations of lead are below the NAAQS (which is most of the country). Such a step would greatly increase gasoline availability, reducing price increases and fuel switching induced by shortness of supply or price considerations. At the same time, it would not impede attainment of the lead standard.

As an alternative step, EPA may consider lead use in gasoline to be variable in time, with credit obtained for using less lead than required (in the winter, when octane requirements and gasoline consumption decreases), and consumption of banked credits allowed in the summer (with peak demand and octane requirements). This action would provide relief during summer months and may forestall the development of spot shortages in an otherwise strained supply system.

Extension of the lead phasedown program may cease to be a viable mitigation measure if current plans to scrap certain lead additive production facilities are implemented.* Accordingly, the desirability of this measure should be fully considered before October 1979, when the facilities are planned to be closed.

V D Other Potential Mitigating Measures

*Comments of Dupont and PPG on the DEIS.

V D-1 Excise Tax Adjustments to Reduce Price Differences

Presidential adviser Alfred Kahn, in recent testimony before the Energy and Power Subcommittee of the House Interstate and Foreign Commerce Committee suggested adjusting the Federal excise tax on gasoline to control the price differential between leaded and unleaded gasoline.* Proponents are of the opinion that by reducing the tax on unleaded gasoline and raising the tax on leaded, the Government could reduce the price differential without distorting the market. This action would reduce the incentive for fuel switching motivated by price considerations. It would be equally useful in conjunction with either continued regulations or deregulation.

Implementation of this measure would require enactment of new legislation. The concept is currently being studied by several agencies. One potentially negative factor which must be considered prior to further action is the possibility that retailers might adjust their prices to offset the intended effect of the tax adjustment.

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* A similar suggestion was made by the Independent Gasoline Marketers Council in its comments on the Draft EIS.

VI RELATIONSHIP BETWEEN SHORT TERM IMPACTS AND LONG TERM ENRICHMENT OF MAN'S ENVIRONMENT

The proposed actions will have certain short term impacts as discussed in Chapter IV which can be mitigated to some extent by the measures set out in Chapter V. The purpose of these proposed actions is to provide proper incentives to the refining industry so as to avoid the largest of the foreseeable long term impacts, a major shortfall of unleaded gasoline. Such a shortage could cause massive fuel switching, not limited to vehicle owners with performance problems or the desire to save a few dollars but, also among large numbers of owners of unleaded only vehicles for whom it will be difficult to find unleaded gasoline at any price.

To avoid this possibility, new refinery reforming capacity is necessary. The proposed actions serve to present the refining industry with the ability to recoup a return on their investment in this capital outlay. Thus the short term impacts, if any, represent trade-offs to be made for the guarantee of security from the more adverse long term consequences of the no action alternative.

VII UNAVOIDABLE ADVERSE IMPACTS

The impacts discussed in Chapter IV were examined in light of the findings of Chapter V regarding the effectiveness of mitigating measures. Promulgation of more stringent price posting regulations, enactment of an excise tax adjustment program and reimposition of the state set-aside program would reduce, although not eliminate, adverse socio-economic, air, and market shift impacts during the 1979-1980 period. In the long term, measures such as expanded inspection/maintenance programs will further diminish the impacts of deregulation and tilt. A certain portion of the adverse impacts discussed in Chapter IV will continue regardless of mitigating measures employed at least until approximately 1981, when unleaded gasoline is projected to comprise a significant portion of the total gasoline market. At that time, if it is in adequate supply it may be marketed more aggressively and the price differential should begin to decrease, thereby eliminating most, if not all, of the price motivated fuel switching.

VIII. IRREVERSIBLE AND IRRETRIEVATLE COMMITMENT OF RESOURCES

Under the assumptions of the EIS, gasoline supply is expected to meet demand through the 1980 timeframe, although supplies may be tight. Thus, the alternatives do not affect the commitment of resources directly. However, the alternatives to continued regulation, acting through the price elasticity of gasoline, serve to diminish consumption of that product by an estimated one percent during 1980. Thus, the alternatives to continued regulation show a benefit in the conservation of petroleum. Balancing that is the induced construction of further reforming capacity, requiring certain materials for construction, and the resultant consumption of petroleum to produce the higher grade gasoline products.

IX CONSIDERATIONS OFFSETTING ADVERSE IMPACTS

As previously discussed in Section II A-1, there are three principal reasons for proposing to remove the present controls on motor gasoline. First, because the controls do not explicitly allow refiners to obtain a return on capital investment, they have a chilling effect on investments in new and needed refining capacity. Second, due to existing allocation restrictions, refiners and marketers do not now possess the necessary flexibility to efficiently market their products, which tends to lessen competition. Finally, the regulations impose upon the industry an administrative burden which, to the extent that these controls are no longer serving the purposes for which they were designed in 1974, are costly and unnecessary.

DOE desires to remove these obstacles to increased and improved refinery output and efficient marketing, and, prior to reaching a decision on removing the present controls, will weigh these benefits against the potential adverse impacts which might result from each of the alternatives. The analysis of these potential impacts is found in Chapter IV, sections B and C.

X SUMMARY OF COMMENTS RECEIVED

The Department of Energy received written comments on the Draft EIS from eight Federal government agencies, 14 State government agencies, 14 refiners, six petroleum industry trade associations, one automobile manufacturer, one consumer advocate, and five individuals. In addition, ten prepared statements were presented at the December 19, 1978 public hearing. Fifteen refiners also sent written comments on the EIA "Analysis Memorandum: 1980 Motor Gasoline Supply and Demand." (Appendix F.) All of these comments and prepared statements have been published in Volume II of the Final EIS. DOE has attempted to respond to all substantive comments in the text of the Final EIS.

The bulk of the comments received dealt with the issue of possible adverse air quality effects which would arise from the misfueling of vehicles designed for use of unleaded fuel only. In this appendix, these comments have been grouped around the four links in the causal chain necessary to show that gasoline deregulation or implementation of the "tilt" regulation could be responsible for such adverse effects. These four subdivisions are: the relationship of deregulation to an increase in the price differential between leaded regular and unleaded regular gasoline, the relationship of the price differential to an increase in misfueling of unleaded only vehicles, the relationship of misfueling to an increase in total vehicular emissions and the relationship of increased vehicular emissions to delays in regional attainment of ambient air quality standards.

In addition, a number of comments addressed the EIA Analysis Memorandum and the supply/demand analysis in Chapter III of the DEIS. These comments are grouped separately. Finally, other comments not directly falling within the foregoing breakdown are grouped together.

I Deregulation's Effect on Price Differential

A. Comments on Assumptions Made in the DEIS

- The DEIS was in error for assuming that price differential increases would be allotted evenly across the retail market. It is possible that deregulation will have a greater effect on those retailers currently showing low differentials (Center for Auto Safety).

- It is questionable whether the data used in the DEIS, collected in a controlled market can be extrapolated to a decontrolled market if the present controls are in any way constraining prices at the refiner or retailer level (EPA.

- DOE's base case assumptions are questionable because continued regulation will cause the industry to increase the differential in order to dampen demand for the product which will be in shortest supply, unleaded gasoline (ARCO and other refiners).

- The introduction of unleaded premium by various refiners will increase competition in the unleaded market and thus decrease prices for the currently available product, unleaded regular (Chevron).

- Deregulation should have little effect on the differential since the major cause of high price differentials is the low prices being charged for the "loss leader," leaded gasoline (National Oil Jobbers Council and a number of refiners).

- The projected price increases due to deregulation are out of line with historical trends and the EIS should account for the recent OPEC price increase (Nelson Oil).

B. Comments on the Methodology Used in the DEIS

- The effect of the President's price guidelines on gasoline prices should be taken into account when evaluating the post-deregulation market (Chevron).

- Are the cost and price projections made in the DEIS in current or inflated dollars?

II The Price Differential's Effect on Fuel Switching

A. Comments on the Data Used in the DEIS

- The Sobotka study is the most accurate information available indicating the sensitivity of fuel switching to price differential and thus should be considered by DOE in its analysis (EPA).

- Use of the General Motors data used in the DEIS is questionable because it contains only two observations at price differentials higher than 5 cents while the Lundberg Survey (Vol. V, No. 21) indicates that 40% of self-serve retailers nationally market gasoline at differentials of higher than 5 cents. A study of the Washington, D.C. area also showed a large percentage of retailers to be above the 5 cent differential level. The use of national average differentials in computing fuel switching is questionable because price differential spreads vary substantially across the U.S. (Center for Auto Safety).

B. Comments on the Assumptions Made in the DEIS

- The DEIS was inaccurate in assuming that the EPA observational study could have mistakenly classified 4.2% of the observed leaded gasoline capable vehicles as unleaded only vehicles (EPA).

- The EPA study was too small to be assumed accurate (George E. Stoertz).

- The fuel switching rate has not yet stabilized and the DEIS underestimates future fuel switching behavior because the catalyst equipped vehicles analyzed in the DEIS are still relatively new and have yet to pass to poorer second and third owners who will have more economic incentive to switch fuels (California Air Resources Board).

C. Comments on the Methodology Used in the DEIS

- The DEIS underestimates fuel switching by not including in its analysis a factor to account for the psychological effect that the passing of unleaded gasoline prices through the "decade" points (i.e., from 69 cents per gallon to 70 cents) ahead of leaded fuel has on misfueling behavior (EPA).

- The AMOCO study shows that the DEIS erred in not isolating price related fuel switching from performance oriented fuel switching (AMOCO).

- The DEIS misapplied the GM study to show that fuel switching does not increase after a vehicle is 3 years old. The GM study is suspect because of the mode of data collection (the motorists were aware of the presence of the observer). The EPA study was unduly criticized by the DEIS because of its failure to recognize the presence of "reverse switching" (Center for Auto Safety).

III The Effect of Fuel Switching on Vehicle Emissions

A. Comments on the Data Used in the DEIS

- Data on impairment of 3 way catalysts must be considered in projecting 1980 emissions. This would require analysis of NO_x levels (EPA and California Air Resources Board).

- Data exists which indicates that less than an 8-fold increase in emissions will result from rendering a catalytic converter inoperative (American Petroleum Institute).

B. Comments on the Assumptions Made in the DEIS

- The emission factors used by the DEIS (7 to 10) are overstatements which result from the mistaken assumption that true catalyst efficiency is 85 to 90% and that complete deactivation results from the use of leaded fuel. EPA's in-use emission factors would give a more accurate result (Ford and API).

C. Comments on the Methodology Used in the DEIS

- It is more accurate and the EIS should estimate the amount of emissions increase from the number of drivers projected to have fuel switched twice or more, rather than assuming a rate of "consistent" switching (EPA, AMOCO and Center for Auto Safety). Similarly, emission factors for deactivated catalysts are not accurately portrayed (EPA - see their attached document).

- The emission factors used do not adequately represent the national auto fleet, given the higher standards which California and 1980 Federal vehicles must meet (Center for Auto Safety).

- Fuel switching effects are underestimated because the DEIS does not account for less than "consistent" fuel switching (California Air Resources Board).

IV The Effect of Vehicle Emissions on Ambient Air Quality

A. Comments on the Data Used in the DEIS

- Regional air quality levels used at page III-43 are not accurate (EPA).

B. Comments on the Assumptions Made in the DEIS

- The description of vehicle inspection/maintenance programs as mitigating ambient impacts naively assumes (1) that such programs can detect defective catalysts when studies show that this is not the case and (2) that state authorities will allow such programs to continue if all vehicles with defective catalysts are forced to replace them (Center for Auto Safety).

- The effects of fuel switching emissions are understated by the assumption that all air quality control regions will attain the ambient air standards for all pollutants by 1987. Their data for Southern California indicates otherwise. Thus any increment added to ambient pollution will contribute to attainment delays of indeterminate length (California Air Resources Board).

C. Comments on the Methodology Used in the DEIS

- It is not appropriate to use a constant rate of ambient pollutant abatement to project attainment delays due to deregulation since the rate of improvement in air quality is premised on a certain rate of mobile source abatement due to cleaner cars being added to the fleet as dirtier ones are retired. Fuel switching affects this abatement rate and thus a constant slope relationship between tons per year fuel switching pollutants and attainment delay cannot be presumed (EPA and California Air Resources Board).

- The predicted attainment delays are overstated because such delays are not analyzed against a base case which includes the attainment problems which would result from the fuel switching which would result from the unavailability of unleaded regular gasoline which might occur if a supply shortage were to occur because deregulation and/or gasoline tilt were not implemented (American Petroleum Institute).

V Comments Addressed to the Supply/Demand Analysis in the DEIS and Analysis Memorandum:

- The supply data in the EIS is inadequate (Center for Auto Safety). Similarly, a complete supply/demand discussion should be included in the EIS (Federal Trade Commission).

- Supply/demand discussion does not reach a conclusion as to whether shortfalls will occur at high demand scenarios. This is not an adequate framework for reaching a decision on deregulation (Nelson Oil).

- Continuation of controls could adversely affect gasoline supplies and the effects of this assumption should be taken into account in the base case (most refiners).

- The report does not consider the supply/demand effects of the price increases that would result from deregulation, implementation of the tilt regulation or adoption of the other alternatives (Amoco, Colorado and others).

- The analysis probably overstated the economic growth rate; recent Council of Economic Advisers' estimates would tend to move the "control case" down to the area referred to as the "pessimistic case" (Amoco). Similarly, the EIA demand forecast was based on May 1978 Data Resources, Inc. (DRI) economic simulations that are more optimistic than November 1978 DRI simulations which, if run now, would result in lower demand forecasts (Shell).

- The "low conservation" optimistic and pessimistic cases provide for a 1979-80 average annual increase in demand of 3.7 percent and 3.2 percent, respectively, as compared to the 3.0 percent demand growth experienced during the 1977-78 period; it is questionable to project demand growth at a faster rate during the next two years than in the last two years, particularly when it is recognized that DOE has allowed for 430 MB/D conservation in the 1980 figure - a level estimated to be at least twice the rate experienced in 1978 (Shell).

- There may be considerable misunderstanding about the term "impact of conservation" which, in the analysis, appears to relate more to the concept of mandated car performance than adjusted personal driving habits (Amoco).

- DOE's demand projections are questionable because of this year's heavy autumn demand that could signal a trend. Recent allocation of supply by a number of the major oil companies needs more discussion. (Nelson Oil).

- DOE's projections of supply and demand are both too high. As to the DEIS conclusion that suppliers should have "sufficient flexibility to supply the expected range of demands," industry supplies are very tight and flexibility is at a minimum. The ability to tolerate significant problems is minimum. We'll have to be lucky to get through the next year unscathed (ARCO).

- The 1980 summer peak demand - the period most likely to be critical - is not discussed at all (Shell).

- The statement in the Analysis Memorandum that gasoline produced by domestic refiners is sufficient to justify even extremely high demand cases is not supported by the analysis which demonstrates that the high level of demand would be satisfied only when lead and/or octane standards are relaxed (Shell).

- Because demand is projected to flatten by 1982, it is an incorrect assumption that the major oil companies will undertake significant refinery expansions either with or without regulation (Nelson Oil).

- The operation of refineries at 94 percent of capacity may be possible for relatively sustained periods, but to annualize this peak seems extraordinarily high (Amoco). Similarly, only 92 percent of maximum design capacity is sustainable, not 94 percent (Chevron).

- A 90-92 percent crude oil capacity utilization rate is attainable although the refining industry has not yet operated their crude distillation units at a calendar year average utilization rate of that level. A 94 percent average on-stream factor for the major downstream units such as catalytic reformers, catalytic crackers and alkylation units is attainable. However, a more reasonable expectancy for hydrocrackers would be approximately 83 percent (Shell).

- The use of models like the RPMS refinery model which treats the U.S. refining industry as a composite of all refineries usually tends to generate a better or more idealistic solution than attainable in real life. Supply, logistical, geographical and other constraints related to individual refineries are simplified or ignored (Shell).

- U.S. motor gasoline imports have never exceeded 215 MB/D over a calendar year, which causes uncertainty over the assumed import availability of 300 MB/D in the Analysis Memorandum, particularly when the questions of quality, seasonal availability and price are considered (Shell; also Texaco and Chevron).

- The assumption is not accurate that the octane level of premium unleaded gasoline will equal the octane level (R+M/2 = 89.5) of leaded regular gasoline (Chevron). Similarly, the octane level of unleaded premium gasoline will range between 91 and 92 (R+M/2) (Union).

- The assumption is not accurate that octane quality will remain constant at today's levels for all grades (Chevron).

- The forecast 1980 market shares for each type and grade of gasoline are not accurate (Union).

- The methodology used in the demand forecasting model is questionable in the following respects:

  a. The use of population and/or drivers is suspect as indication of gasoline demand because population does not vary with the economic climate the way gasoline demand does.

  b. Personal consumption expenditures would be a better indicator of demand than real national income.

  c. Since approximately 40 percent of gasoline sold is through self-service outlets, a demand forecast based on a weighted average of full-service and self-service prices would be more representative than a forecast based solely on full-service prices.

  d. Reliance on prices of leaded regular gasoline only presumes continuation of historical grade differentials. However, in the present market, leaded regular is frequently discounted to attract the price conscious buyer, and as a consequence, grade differentials have changed. A composite price representing all grades of gasoline would be preferred. A weighted composite price would also reflect the changing mix among grades of gasoline.

  e. No alternative demand scenarios were used which take into account significant factors affecting 1978 growth such as non-observance of speed limits, increase in recreational vehicle population and sun-belt growth rate (Shell).

- The analysis should have separately analyzed gasoline supply and demand for Petroleum Administration for Defense District V, particularly with its heavy crude problems and other unique characteristics (Chevron).

VI <u>Comments Addressed to the Impacts of the Proposed Actions and the Other Alternatives (other than those concerning the relationship between deregulation and misfueling)</u>

- The impacts of no action should be more fully discussed; with no action there will be a drastic shortfall of unleaded gasoline (National Oil Jobbers Council; also most refiners). Similarly, price controls will increase misfueling because they constrain the production of unleaded gasoline (American Petroleum Institute).

- Existing price rules for unleaded gasoline are a disincentive to the production of high octane unleaded gasoline because base date prices for unleaded may be set only one cent per gallon above the base date prices for leaded gasoline of the nearest octane; the one cent difference does not reflect the actual additional cost of manufacture (Sohio).

- Existing regulations may cause higher prices by encouraging inefficient use of resources at the refinery level (Federal Trade Commission).

- The purchasing of foreign gasoline by domestic refiners faced with a shortage could raise prices to levels higher than under deregulation (Federal Trade Commission).

- The DEIS did not adequately address the inflationary impact of deregulation (California Air Resources Board).

- The DEIS did not adequately address the inflationary and other impacts following deregulation in marginal marketing areas, such as West Virginia; with lower volume of sales and higher marketing costs, marketers would be less willing to serve West Virginia, except at higher prices (West Virginia; also Vermont).

- The EIS should address the continuation of the state set-aside for motor gasoline (West Virginia, also Michigan and Colorado).

- The EIS should address energy conservation objectives achieved by higher prices (Colorado).

- The DEIS is contradictory as to whether the number of retailers will decrease as a result of deregulation (Federal Trade Commission).

- The DEIS erroneously concluded that total actual cost passthroughs would not be as high under the tilt alternative as under deregulation; the price increase at the refinery level will be the same under both actions (Federal Trade Commission).

- Concerning the impacts of refinery expansion following deregulation, the EIS should consider:

  a. the effect of the EPA's emission offset policy and Prevention of Serious Deterioration regulations;

  b. that additional processing equipment would result in an increase in effluents, but without significant adverse impact on water quality. Because of rigid standards for permits, there would be no significant effect;

  c. that solid waste increase will be small and can be handled in existing sites;

  d. that other refinery impacts, as to noise, toxic substances and land use will be small (Texaco).

- The EIS should recognize that the effect of regulating the price differential between leaded and unleaded gasoline will be to raise the prices of leaded gasoline and to eliminate dealer competition on leaded gasoline (ARCO and Chevron).

- The regulated differential alternative will reduce the production of unleaded premium gasoline (ARCO).

- The possible adverse effects of regulating the resultant price differential should be more thoroughly explained, including marketing strategies to increase sales of leaded gasoline, such as elimination of self-service pumps for unleaded gasoline (Federal Trade Commission).

- A shortfall situation is not addressed in sufficient detail in the DEIS, especially given the OPEC price increase, the Iranian interruption and the recent Shell situation (Center for Auto Safety; also Nelson Oil).

- The EIS should discuss the use of a tax mechanism to control the price differential between leaded and unleaded gasoline (Independent Gas Marketers Council).

- Gasohol should be considered as a clean gasoline additive and as an alternative to increased reforming capacity (Pincas Jawetz).

- If the tilt is implemented, a mechanism should exist to ensure that refiners do not achieve a double recovery by recouping the same costs on both heating oil and gasoline (Empire State Petroleum Assoc.). Similarly, with respect to double recovery on jet fuel and gasoline (Air Transport Association).

- The EIS does not discuss the subsidization of gasoline costs by heating oil customers under the no action alternative (Empire State Petroleum Assoc.; also New England Fuel Institute and Oil Heat Institute of Long Island).

- The EIS does not address the adverse effects of NO_x, nitrates, sulfates, and organic aerosols due to emission control deactivation (California Air Resources Board).

- The EIS overstated the cost increases due to EPA's lead phasedown program (American Petroleum Institute).

APPENDIX A

APPENDIX A

ESTIMATION OF FUEL SWITCHING RATE

The draft EIS concentrated on developing the price sensitivity, if any, of misfueling. Numerous commenters presented views and evidence, however, that fuel switching is also performance motivated. Certainly the GM survey shows performance motivation in the data of aging cars. The question remains of how best to determine the motivation of fuel switches. The purpose of this Appendix is to develop estimates of the extent to which fuel switching is price motivated.

This EIS will use data which has been observed in the field and data that has been obtained from survey respondents who reported their actual past behavior. The Sobotka survey trade-off analysis, which attempts to project future behavior, has been shown in Chapter III to be unrelated to real market conditions and will not be used.

The sensitivity of fuel switching to price will be examined in two regimes: the first is 0-9¢ price differential and the second is 10¢ plus, as EPA field observed data seem to indicate a break point at 10¢.

As demonstrated in the text of Chapter III, there is a base rate of fuel switching, unrelated to the EIS alternatives, which does not affect the calculation of incremental impacts resulting from the alternatives. Here, only the incremental fuel switching as created by the alternatives will be derived.

The price sensitivity of fuel switching observed in a survey can be presented by fitting a least squares regression line through the observed data of the study. The regression coefficient for slope, b_1, is the measure of the increase of fuel switching rate (in percent) per penny increase in price differential.

Results from various studies show:

Survey	b_1	Correlation Coefficient*
GM	.172	.43
EPA	-.16	-.06
EPA (panel survey, definite switchers)	.38	.61
EPA (panel survey, probable switchers)	.57	.58
DEIS (expected value)	.02	
DEIS (worst case)	.98	

The negative value in the EPA study is the result of not including data points at 10¢ plus. These data are very few and scattered, and a two regime analysis is definitely indicated by the data. The EPA data for 10¢ plus are best represented by the constant fuel switching rate of 15.8%, as compared to the mean below 10¢ of 9.3%, or an increment of 6.5%.

The DEIS figures for price sensitivity of 0.02 and 0.98 bracket the range of values obtainable from observed data. Thus, the DEIS price sensitivity figures will be used in this final EIS as best and worst cases. The expected case sensitivity is best described by averaging the EPA values for definite and probably switchers of 0.38 and 0.57.

The only data available for fuel switching price sensitivity at 10¢ or more per gallon are those of the EPA survey, which show an incremental rate between 0-9¢ and 10¢ plus of 2% (expected case), and 5% (worst case). The DEIS thus understated the incremental fuel switching at a 10¢ plus differential. The expected incremental fuel switching rate for the 10¢ price differential category therefore is set equal to the EPA rate of 6.5%, over and above the average base rate of the 0-9¢ category.

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* Correlation coefficients measure the degree to which the relationship between price and performance is valid. The EPA data showing a result of -.16, with a correlation of -.06, is best described as showing no relationship between price and fuel switching.

APPENDIX B

APPENDIX B

DATA ON FUEL SWITCHING

Data From the EPA Study Differentiated by the Various Price Differentials between Unleaded and Leaded Regular Fuel*

Price Differential (cents/gallon)	Unleaded Vehicles Observed	Fuel Switchers Observed	Fuel Switching Rate (%)
1¢	7	1	14.3
2¢	100	5	5.0
3¢	328	31	9.5
4¢	287	23	8.0
5¢	111	13	11.7
6¢	64	4	6.3
7¢	24	1	4.2
8¢	8	2	25.0
9¢	1	0	0.0
10¢	18	2	11.1
11¢	7	1	14.3
12¢	10	3	30.0
13¢	22	3	13.6

Estimated Probability Distributions for the Fuel Switching Rate at Various Price Differentials Based on the EPA Study

1. Price differential of 1¢ to 3¢

Fuel Switching Rate	Probability
0% to 5%	.01
5% to 10%	.86
10% to 15 %	.13

* Ref. III-8

2. Price differential of 4¢ to 6¢

Fuel Switching Rate	Probability
0% to 5%	.00
5% to 10%	.85
10% to 15%	.15

3. Price differential of 7¢ to 9¢

Fuel Switching Rate	Probability
0% to 5%	.42
5% to 10%	.23
10% to 15%	.27
15% to 20%	.07
20% to 25%	.01

4. Price differential of at least 10¢

Fuel Switching Rate	Probability
0% to 5%	.02
5% to 10%	.10
10% to 15%	.32
15% to 20%	.37
20% to 25%	.16
25% to 30%	.03

Data From the GMC Study Differentiated by the Various Price Differentials Between Unleaded and Leaded Regular Fuel

Price Differential (cents/gallon)	Unleaded Vehicles Observed	Fuel Switchers Observed	Fuel Switching Rate (%)
2¢	167	1	0.60
3¢	235	3	1.28
4¢	582	11	1.89
5¢	162	5	3.09
8¢	62	1	1.61

Estimated Probability Distributions for the Fuel Switching Rate at Various Price Differentials Based on the GMC Study

1. Price differential of 1¢ to 3¢

Fuel Switching Rate	Probability
0% to 5%	.999

2. Price differential of 4¢ to 6¢

Fuel Switching Rate	Probability
0% to 5%	.99

3. Price differential of 7¢ to 9¢

Fuel Switching Rate	Probability
0% to 5%	.98
5% to 10%	.02

Estimated Probability Distributions for the Fuel Switching Rate According to Vehicle Year, Based on the GMC Study

1. 1975 vehicles

Fuel Switching Rate	Probability
0% to 5%	.44
5% to 10%	.56

2. 1976 vehicles

Fuel Switching Rate	Probability
0% to 5%	.99
5% to 10%	.01

3. 1977 vehicles

Fuel Switching Rate	Probability
0% to 5%	.999

4. 1978 vehicles

Fuel Switching Rate	Probability
0% to 5%	.999

DATA FROM EPA QUESTIONNAIRE SURVEY

Price Differential	Percent Definite Switches
0-2¢	4
3-5¢	6
6-7¢	4
8¢+	8

Price Differential	Percent Probable Switches
0-2¢	8
0-3¢	11
6-8¢	7
9¢+	15

APPENDIX C

APPENDIX C

THE EFFECT OF MISCLASSIFICATION ERRORS ON THE FUEL SWITCHING RATE

There is substantial difference between the fuel switching rates reported in the General Motors Corporation and Environmental Protection Agency studies. It is thought that perhaps, because of the way in which the sample was taken in the EPA study, some vehicles may have been misclassified as requiring unleaded or leaded fuel. This could be a very important problem because only a relatively small number of misclassifications could explain the difference in the fuel switching rate between the two studies.

The four possible misclassifications along with their effects on the fuel switching rate are as follows:

- A true leaded vehicle is classified as an unleaded vehicle and...
  - (1) refuels with leaded fuel. This is a correct refueling which is viewed as fuel switching and inflates the fuel switching rate.
  - (2) refuels with unleaded fuel. This is a possible, but probably unlikely (for performance reasons), refueling which is viewed as an unleaded vehicle making a correct refueling and so deflates the fuel switching rate.
- A true unleaded vehicle is classified as a leaded vehicle and...
  - (3) refuels with leaded fuel. This is an instance of fuel switching which is missed and so the fuel switching rate is deflated.
  - (4) refuels with unleaded fuel. This is a correct refueling by an unleaded vehicle which is also missed and so the fuel switching rate is inflated.

Assuming that all vehicles are just as likely to be misclassified and noting that there are approximately two to three times as many leaded vehicles as unleaded vehicles in the U.S., one can expect that more misclassifications of types (1) and (2) would occur. Further, assuming that very few leaded vehicles refuel with unleaded fuel, because of decreased engine performance, misclassifications of type (1) would occur more frequently than all the other kinds of misclassifications. In addition, since the true fuel switching rate is probably well below 50%, misclassifications of type(3)are more likely than those of type (4), and probably type (2) also. In summation, the types of misclassifications which tend to inflate the fuel switching rate seem to be much more likely to occur.

EPA observes that they found 110 misfuelings from 1160 unleaded vehicles. In order for the fuel switching rate to be 2% instead of 10%, as EPA concluded, some 89 of the 110 observed violations would have to be in error. The misclassification error which would produce this result would be the erroneous classification of only 89 out of 2320 leaded vehicles (assuming the leaded population to be twice the unleaded), or a misclassification rate of about 4%.

EPA, in its comments on the DEIS, pointed out that all data were screened and those observations which could not be verified by state motor vehicle agencies were dropped. It is thus likely that there were few, if any, misclassifications. The point of the discussion in the DEIS, however, was only to illustrate the potential for significant upward bias in the EPA results.

Similarly, a bias exists in the GM survey because of the requirement of informed consent from those who were observed misfueling. If each refusal to participate in the survey was by a misfueler, then the true misfueling rate in the GM study was the observed misfueling rate plus the ratio of the number of refusals to the number of observed unleaded vehicles. While this bias is not potentially as large as the EPA bias, the presence of the bias serves to lower the observed misfueling rate.

APPENDIX D

APPENDIX D

REGIONAL POLLUTANT EMISSIONS AND AMBIENT AIR QUALITY

Carbon monoxide, one of the two major pollutants affected by misfueling, is a primary pollutant, with potentially significant direct effects on man and his environment. Hydrocarbons, on the other hand, have their major effect by stimulating the photochemical production of oxidant, a secondary pollutant with significant health effects.

On the national level the impact of refueling must be measured by the emissions of CO and hydrocarbons themselves. On a local scale, the impact can be measured by the ambient concentrations of carbon monoxide and oxidant resulting from emissions of carbon monoxide and hydrocarbons.

The tools to model the ambient concentrations can be very complicated, as in photochemical dispersion models, or simple, as in rollback models and photochemical production charts. We have chosen the simpler approach, both because of the widespread use of these tools, and because the precision afforded by the more complex model is not justifiable in the light of the uncertainties in the data supporting the models.

As a consequence of the Clean Air Act Amendments of 1977 each state is involved in revising its State Implementation Plan (SIP) to demonstrate achievement of ambient air quality standards. For the pollutants produced primarily by motor vehicles -- carbon monoxide, hydro-carbons, and nitrogen oxides -- the attainment of ambient standards must be achieved by 1982 unless the State requests an extension of the attainment deadline to 1987. Principal emphasis for the vehicular-pollutant control strategies is directed toward urban areas. A prime component of each plan is the Federal Motor Vehicle Control Plan (FMVCP) calling for increasingly strict pollutant emission standards for new cars. In many cases the entire SIP strategy for attaining carbon monoxide and oxidant standards by 1982 or 1987 is based on the expected replacement of old automobiles with new low-emission vehicles. Where the FMVCP is not sufficient to reduce emissions, the states must place additional controls on sources of pollution or develop strategies which reduce vehicle emissions by encouraging reduced usage of automobiles and trucks.

As a consequence of the SIP revisions, the states have had to investigate vehicle travel between the present and 1987 as well as projecting what year their control strategies can result in attainment of ambient carbon monoxide and photochemical oxidant standards. In making their projections the states have used a variety of models. The most complex of these are the photochemical dispersion models while the simplest is the linear rollback model. The latter model uses the concept that ambient concentrations of a pollutant are directly proportional to emissions of that pollutant. This approach is primarily used for evaluating carbon monoxide strategies. However, it has also been shown to be an acceptable approximation for testing the effect that emissions of hydrocarbons will have on ambient oxidant concentrations, especially when transport of pollutants into the area can be disregarded.

In assessing the effects of misfueling on ambient concentrations of carbon monoxide and oxidants, data were acquired from several urban areas which were developing control strategies for their SIP's. The concept of the direct proportional relationship between emissions and air quality, which is the basis for the rollback equation, was used.

Three urban areas--Washington, D.C.; Los Angeles, California; and Denver, Colorado--were used to assess the effect of misfueling on air quality. Each of these cities currently has concentrations of carbon monoxide and photochemical oxidant which violate the ambient standard. They do not expect to attain the standards until after 1982 and in some cases they will need control strategies in addition to the FMVCP to attain the standards by 1987.

Methodology

For each of the cities we used the planning area which the city itself is using in developing its control strategy for motor vehicle emissions. The areas were: 1) Metropolitan Washington which is composed of the District of Columbia plus adjacent counties in Maryland and Virginia, 2) the Los Angeles Air Basin which includes Los Angeles and Orange Counties plus part of Riverside and San Bernardino Counties, and 3) urbanized Denver. Estimates of vehicle miles traveled (VMT) in these three areas were available for some base year (1976, 1977 or 1978), and for the two future years--1982 and 1987. It was assumed that the VMT changed linearly between these three years.

Development of control strategies for these areas entails the calculation of projected emissions for future years. This is done by multiplying the estimated VMT for each area by a composite mobile source emission factor applicable to that City for the years in question. The total annual emissions computed by these multiplications can be used in rollback equations to test whether ambient concentrations will be achieved. The composite mobile source emission factors take into account a number of variables including mix of vehicle types, vehicle distribution by age, mandated emission controls on new vehicles, deterioration, speed of travel, percentage of cold starts, average ambient temperature, altitude of the area and use of air conditioners. The EPA report, "Mobile Source Emission Factors", provides a compilation of the base emission factors and correction factors applicable to various conditions in past, present, and future years. Composite emission factors in this report were determined for the conditions of the Federal Test Procedure (FTP), which are listed in Table D-1. The EPA exhaust emission surveillance program provided the data on performance and equipment deterioration from which the emission factor projections were developed.

In assessing the impact of misfueling on air quality in the three cities we obtained a 1980 mobile source composite emission factor from the information provided in the EPA report. While it is possible to develop special factors for California and for high-altitude areas such as Denver the calculations were simplified by using the same 1980 factor in each of the three areas. This factor was based on the FTP conditions and also on the nationwide distribution of vehicles listed in the EPA report. The mix of vehicle types (percentages of autos and trucks) used in the assessment was chosen to resemble the mix being

TABLE D-1. FEDERAL TEST PROCEDURE CONDITIONS FOR LIGHT DUTY VEHICLES (Automobiles)

Absolute humidity	75 grains
Ambient temperature	75°F
Average speed	19.6 mph, 18% idle operation
Average cold operation	21%
Average hot start operation	27%
Average stabilized operation	52%
Air conditioning not in use	
Car contains driver only	
Car is not pulling a trailer	
Vehicle is not in an inspection/ maintenance program	
Vehicle receives typical in-use maintenance	

Source: "Mobile Source Emission Factors", EPA document EPA-400/9-78-005, Washington, D.C., March, 1978.

used by the state or local agency which is developing the control strategy for the SIP revision. In Metropolitan Washington the VMT's are divided between automobiles and trucks on a 88 to 12 percent ratio respectively. In the Los Angeles Air Basin 78 percent of the vehicle CO emissions are from automobiles. In urbanized Denver automobiles comprise between 60 to 65 percent of the VMT.

Using the information provided by the various agencies involved in developing vehicle emission control strategies, estimated concentrations of oxidant and carbon monoxide were determined for 1980. These estimates were derived from the pollutant strategy "design value", the ambient standard, and the year in which the standard is expected to be attained. The design value is the value of the pollutant concentration measured in the base year (1975 through 1978) over the same averaging period as the standard. It provides the magnitude of the difference between prevailing air quality and the standard. In the interpolation of an expected 1980 value it was assumed that there would be a linear decrease in annual pollutant concentration from the base year to the attainment year.

Another important simplifying assumption made in this investigation was that all improvement in CO and oxidant air quality would result from decreases in local-area vehicle emissions. That is, no changes in the amounts of pollutants transported into the area or in stationary source emissions were considered.

Finally, 1980 vehicle emissions were calculated using the composite emission factor and the interpolated 1980 VMT. Then increases in area emissions for each of the light-duty vehicle misfueling possibilities were calculated using the same misfueling used in the nationwide calculations. Under the assumption of a direct relation between emissions and air quality the percentage of increased emissions was multiplied by the expected 1980 pollutant concentrations to estimate increments in 1980 CO and oxidant concentrations resulting from misfueling. These are presented in Table D-2.

TABLE D-2. PROJECTED AMBIENT CONCENTRATION OF CARBON MONOXIDE AND PHOTOCHEMICAL OXIDANT UNDER THE GASOLINE CONTROL SCENARIOS

City	Pollutant	Projected Concentration in 1980	Maximum Concentration Expected: Worst Case Deregulation	Maximum Concentration Expected: Expected Case Deregulation
Washington, DC	Carbon Monoxide[a]	12.6 ppm[c]	13.6	12.6
	Oxidant[b]	0.115 ppm	.118	.115
Los Angeles, CA	Carbon Monoxide	22.3 ppm	23.4	22.3
	Oxidant	0.360 ppm	.368	.360
Denver, CO	Carbon Monoxide	20.3	21.8	20.3
	Oxidant	0.161	.166	.161

(a) CO value is the second highest 8-hour average during the year.
(b) Oxidant value is the second highest 1-hour average during the year.
(c) Parts per million.

It is informative to calculate the effect that an increase of pollutant emissions from vehicles would have on the attainment of the ambient standards for carbon monoxide and photochemical oxidant concentrations. For example, what delay in achieving these standards would result if vehicle emissions were greater than the State Implementation Plans have used in their projections? An estimate of this delay can be made using the assumptions that the entire carbon monoxide and oxidant problem in a region is a consequence of emissions within that region and that the solution to the problem will come from the reduction of vehicle emissions. Thus, if there were an increase in emissions, the rate at which the SIP reduces the ambient concentrations would be the same, but it would take longer to reach the goal. By using the direct-proportionality rollback model a percentage increase in regional pollutant emissions from vehicles results in the same percentage increase in ambient pollutant concentrations in the region.

Results of the sensitivity of standards attainment date to an increase in emissions is presented in Table D-3. The delay in attainment is longer in the Metropolitan Washington area than in the Los Angeles and Denver regions. The smaller delay in the latter two regions is a consequence of the rapid (approximately 1.7 ppm/year for CO) rate of air quality improvement needed to attain standards by 1987 in Los Angeles and Denver. In Washington where the current pollutant concentrations are not as high (0.72 ppm/year for CO) the rate of improvement is not so great. As a result it would take longer to overcome an increase in emissions.

TABLE D-3. RATE OF ATTAINMENT OF AMBIENT STANDARDS FOR CARBON MONOXIDE AND PHOTOCHEMICAL OXIDANT

Region	Pollutant	Year Ambient Standard is Expected to be Attained under SIP	Linear Rate of Improvement (ppm/yr)
Washington, DC	CO[2]	1987	0.59
	Oxidant[3]	1987	.11
Los Angeles, CA	CO	1987	1.91
	Oxidant	1987	.039
Denver, CO	CO	1987	1.31
	Oxidant	1987	.006

(1) Under the assumptions that there is no transport of pollution across regional boundaries.

(2) 8-hour CO standard

(3) 1-hour oxidant standard.

APPENDIX E

APPENDIX E

ESTIMATED COST INCREASES, 1978-1980 NECESSARY FOR REFINER COMPLIANCE WITH EPA LEAD PHASEDOWN REQUIREMENTS

Estimating the cost impact of lead phasedown regulations is a complex matter. Because of the interactions between the various refinery processes, lead removal affects the entire refinery operation. The additional processing costs include a combination of the costs of catalytic reforming, catalytic cracking, hydrocracking, alkylation, and isomerization operations. Earlier studies (E-1) (E-2) (E-3) of the problem, which employed linear programming optimization methods, were used as the basis for estimating the price differential between the leaded and unleaded grades, taking into account both new investments and increased operating costs. The models use research octane numbers as the measure of gasoline quality, hence the analysis here is in RON.

The approach used treats the United States refinery octane-improvement capacity as a unit built in 1978 and analyzes the cost to supply gasoline of the appropriate quality. Next the cost to build and operate the facilities needed in 1980 is calculated and the difference in cents per gallon calculated. These costs are based on standard cost estimates for the industry in 1974, corrected for inflation to 1978 (1.32) and 1980 (1.49). The figures hold for moderate increases in production under normal conditions. They do not apply to increases provided by "heroic efforts" such as might be required under a crude shortage, widespread strikes, a transportation crisis, etc.

The clear pool octanes, that is the octane numbers of the nation's gasoline pool if no metallic additives are added, were obtained by distributing expected quantities of the lead under the lead phasedown regulations among different grades of gasoline.

The octane of unleaded gasoline was set at 92.3 RON, the expected value of regular unleaded gasoline. The clear octane of premium was set at the same level and the required lead to bring it to 98.9 RON was calculated from a lead susceptibility chart. The total of lead in premium was subtracted from the total expected for the pool to calculate the amount available for regular grade. If the clear octane value for regular determined this way was lower than that assumed from that derived form DOE data, the lead in the regular was set at the required value and the lead in premium adjusted. The clear pool octane was assumed to be the volume weighted average of the values for the 3 grades.

Department of Energy data for summer 1977 (E-4) and winter 1977-78 (E-5), when analyzed in a similar manner, showed the clear RON for regular gasoline to have been 85.4 in the summer and 86.2 in the winter. The summer value was used as the base case to determine the extra processing needs to prepare the entire slate of gasoline products. The additional octane requirement cost calculates for the whole slate of products was distributed over each grade in proportion to the volume multiplied by the additional clear octane needed.

The results are shown in Table E-1, along with the amounts of these cost increases that would be allowed to be passed through under the no action and gasoline tilt alternatives and the amounts by which these figures differ from the full cost. These latter figures are the same for the deregulation, differential control and unleaded control only alternatives. It is worth noting, although it has no significance in further analysis, that the cost difference between leaded and unleaded gasoline in 1980 is estimated at 2.30 cents per gallon, about the same as the 2.02 cents in 1978.

References

E-1. Arthur D. Little, Inc., "Impact of Motor Gasoline Lead Additive Regulations on Petroleum Refineries and Energy Resources -- 1974 -- 1980, Phase I", EPA 450/3-74-032-a, May, 1974.

E-2. Bonner & Moore Associates, Inc., "An Economic Analysis of Proposed Schedules for Removal of Lead Additives from Gasoline", EPA Contract No. 68-02-0050, June 25, 1971.

E-3. Battelle Columbus Laboratories, "Economic Impact of Environmental Regulations on the Petroleum Industry--Phase II Study", API Report 4281, June 11, 1976. (The curves on pp V-117 and V-118 were adjusted to 83.5 clear pool octane and corrected to 1978 prices by using a factor of 1.323. The calculations assume a returning of 12.5 percent on investment after taxes.)

E-4. E.M. Shelton, "Motor Gasolines, Summer 1977", DOE, BERC/PPS-78/1, January, 1978, p. 21.

E-5. E.M. Shelton, "Motor Gasolines, Winter 1977-78", DOE, BETC/PPS-78/3, July 1978, p. 21.

TABLE E-1. COST INCREASES PER GALLON OF GASOLINE FOR OCTANE IMPROVEMENT IN MOTOR GASOLINE (REVISED)

	1000 Barrels/ Calendar Day	Research Octane Number	Lead, g/gal	Clear RON	Added[a] Clear RON	Extra[b] Refining Cost, ¢/gal	Total[c] With Lead, ¢/gal	Diff. From Regular, ¢/gal	Passthru[d] Allowed-- No Action, ¢/gal	Diff. From Regular (No Action) ¢/gal	Passthru[e] Allowed-- Tilt, ¢/gal	Diff. From Regular (Tilt) ¢/gal
						1978						
Regular	3909	93.4	1.64	86.2	0.8	0.38	1.20	---	0.50	---	0.73	---
Premium	811	98.9	2.50	92.3	6.9	3.26	4.51	3.31	1.70	1.20	2.50	1.77
Unleaded	2656	92.3	---	92.3	6.9	3.26	3.26	2.06	1.14	0.64	1.67	0.94
Total or Weighted Avg.	7376	93.6	1.20	89.0	3.6	1.70	2.30	---	0.86	---	1.27	---
						1980 Phasedown						
Regular	3168	93.4	0.93	87.8	2.4	1.50	2.02	---	0.74	---	1.08	---
Premium	603	98.9	2.50	92.3	6.9	4.32	5.72	3.70	2.08	1.34	3.06	1.98
Unleaded	3772	92.3	---	92.3	6.9	4.32	4.32	2.30	1.45	0.71	2.13	1.05
Total or Weighted Avg.	7543	93.3	0.59	90.4	5.0	3.13	3.46	---	1.20	---	1.76	---
						1980 No Change in Lead						
Regular	3168	93.4	2.20	85.4	0	0	1.22	---				
Premium	603	98.9	3.45	91.5	6.1	3.57	5.50	4.28				
Unleaded	3772	92.3	---	92.3	6.9	4.37	4.37	3.15				
Total or Weighted Avg.	7543	93.3	1.20	89.3	3.9	2.28	2.95	---				
Difference 1980-1978						With phasedown	1.16[f]	-0.24[g]	0.34[f]	0.07[g]	0.49[f]	0.09[g]
						Without phasedown	1.11	1.09				

[a] Relative to 85.4 octane
[b] Includes 12.5% return on investment after taxes; costs allocated proportional to added clear RON and fraction of total gallons.
[c] 0.50¢ per gram of Pb, 1978; 0.56¢, 1980
[d] No Return on Investment, 9% interest charge, 45% allocated directly and indirectly to gasoline. Allocation to grade as in footnote (b).
[e] No Return on Investment, 9% interest charge, 42% gasoline production
[f] Pool
[g] Unleaded vs. leaded regular

APPENDIX F

DOE/EIA/0102/32

Analysis Memorandum

United States
Department of Energy
Energy Information Administration
Washington, D.C.

A N A L Y S I S   M E M O R A N D U M
AM/ES/79-12

1980 MOTOR GASOLINE SUPPLY AND DEMAND

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December 8, 1978

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TABLE OF CONTENTS

PREFACE

The Energy Information Administration undertook this study of 1980 motor gasoline supply and demand at the request of the Economic Regulatory Administration of the Department of Energy. It was requested by Applied Analysis Service Request (AASR) Number 79-ES-0009. This analysis updates and expands on a previous EIA Analysis Memorandum of the same name AM/ES/78-19.

The authors of this paper wish to acknowledge significant contributions by David Hulett, Bill Maher, Scott Atkinson, Terry Higgins, and Bob Reinstein for their assistance in the preparation of this report. A speedy and thorough review by Phil Childress, David Montgomery and others was greatly appreciated. Secretarial assistance was provided by Monica Bradley.

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EXECUTIVE SUMMARY

The 1980 motor gasoline supply and demand analysis was undertaken by the Energy Information Administration as part of its continuing analysis of the short-term trends in petroleum product supply and demand. In this report, various assumptions regarding 1980 supply and demand for motor gasoline 1/ are addressed and their effects on the motor gasoline supply and demand balance are analyzed.

The most important of the study assumptions are summarized below:

- The range of economic growth assumptions are bracketed by an optimistic case with an average annual growth rate for the three years, 1978-1980 of 4.5 percent in real GNP and a pessimistic case with an average growth rate of 3.5 percent per year.
- Phasedown of total allowable gasoline pool content of tetra-ethyl lead to 0.5 grams per gallon of gasoline (the EPA October 1979 target) would be in effect by 1980.
- Octane quality would be maintained at today's levels for each grade of gasoline.
- No domestic refining capacity additions other than those already announced or committed would be in use in 1980.

1/ Motor gasoline as used in this report includes all premium and regular, unleaded and leaded gasoline, but excludes aviation gasoline.

- Imports will provide about 300 MB/D of the total gasoline supply in 1980. January through August 1978 imports averaged 193 MB/D.

- Effects of increased automobile fleet efficiency appear to lead to conservation of between 430,000 and 730,000 barrels per day of motor gasoline below the demand levels which would be estimated from recent trends.

- Retail motor gasoline prices were assumed to remain constant in real terms over the forecast period. This, in fact, has been the case for the last four years.

The conclusions of this analysis can be stated in summary form. For 1980 motor gasoline consumption is projected to range from 7.58 MMB/D to 7.96 MMB/D depending on the level of economic activity and the extent of improvement in the fuel efficiency of the automobile fleet. Recent data indicate that automobiles do not perform as well on the road as they do in the Environmental Protection Agency (EPA) gasoline economy tests. Accordingly, a range of measures of fuel efficiency or what we will generally refer to as conservation, are presented below. Depending on the state of the economy, low levels of conservation assumed here indicate a range of 1980 consumption levels which vary from 7.88 to 7.96 MMB/D. With high conservation the levels are from 7.58 to 7.66 MMB/D.

One recent economic projection ("Recession Ahead: New Forecast Summary" by Otto Eckstein, Data Resources, Inc. published November 3, 1978) based on recent Administration actions taken to strengthen the value of the dollar, is for lower economic growth than even the low level represented by the pessimistic growth case in this analysis. Hence, there is perhaps some justification for concentrating on the pessimistic case. For that case, gasoline consumption is projected to be between 7.58 and 7.88 MMB/D with alternative conservation assumptions.

With 1980 consumption of motor gasoline at these projected levels, the refining industry will have to take certain actions to increase supplies, particularly to offset the effects of the sharp phase-down of octane-increasing lead additives. Under authority of the Clean Air Act, the EPA has ruled that lead must be phased out of use. However, as a result of the specific appeals by refiners the EPA has somewhat relaxed its schedule at different points in time while maintaining the end schedule target of .5 grams of lead per gallon by October 1979. This target level refers to total gasoline sold divided by total lead used. Thus, while the EPA is expected to permit lead to be added to the clear (free of additives) gasoline pool at the rate of about 1.2 grams per gallon through most of 1979, the industry will be required to reduce that level to about 0.5 grams per gallon by October. This action puts pressure on downstream refinery units which make high octane clear pool gasoline. The estimated effect of this phase-down is a reduction of possible gasoline output by about 500 thousand barrels per day in 1980.

The refining industry may increase gasoline supplies by increasing capacity utilization rates of downstream units 2/ to levels that are higher than the normal industry practice, using manganese additives in leaded grades as permitted by the EPA, and somewhat reducing the octane rating of some or all of the gasoline grades they produce.

2/ Such as alkylation, reforming, and cracking which upgrade the octane quality of blending components for gasoline after the initial distillation process.

INTRODUCTION

Three major factors have caused the U.S. refining industry to face complex choices concerning its capability to supply acceptable motor fuels at acceptable prices in the near term: 1) uncertain, but possibly increasing demand for all gasoline, 2) reduction in the levels or elimination of octane additives allowable in gasoline, and 3) considerable shifts from previous trends in the U.S. automobile fleet efficiency and octane requirements. This work was undertaken to help understand the range of uncertainty which these three often offsetting occurrences have on total gasoline consumption and the demands to be placed on octane-enhancing refinery unit operations. The analysis uses two analytical tools available to the EIA: the Short-Term Petroleum Product Demand Forecasting Model (STPPDFM) for projections of motor gasoline demand through 1980 and the Refinery and Petrochemical Modeling System (RPMS) for projections of domestic refineries' motor gasoline supply capability through 1980. In this analysis the STPPDFM is used to estimate future motor gasoline demand based on alternate assumptions about economic growth and automobile fuel efficiencies. Next, the refinery model is used to evaluate the capability of domestic refiners to supply the projected demand levels. While not attempting to specify what steps the refining industry would take to ensure adequate supplies, or in what order, the analysis does describe several important options available to the industry to extend supplies.

DEMAND ASSUMPTIONS AND PROJECTIONS

The evaluation of motor gasoline demand through 1980 presented in this Analysis Memorandum is based on, (1) demand projections derived from the Department of Energy's Short-Term Petroleum Product Demand Forecasting Model (STPPDFM), and (2) conservation impacts due to new vehicle fuel efficiency standards derived from the Light Duty Vehicle Fuel Consumption Model (LDVFCM). This section provides brief descriptions of these two models, major assumptions of the analysis, and major results.

Demands are estimated under the assumptions of, (1) three levels of macroeconomic growth, and (2) two levels of conservation due to new vehicle fuel efficiency standards. This results in a range of demand estimates which cover reasonable limits for future levels of gasoline demand.

Short-Term Petroleum Product Demand Forecasting Model (STPPDFM)

The STPPDFM is an econometric model which estimates demands for eight refined petroleum products quarterly for a three year horizon in each of the five Petroleum Administration for Defense Districts. The model consists of equations for each product which relate the demand for that product to key economic and weather variables shown to influence demand. In the current model version, these relations have been statistically estimated based on historical data for the period 1970 through 1976. As an example, the key variables identified in the gasoline demand equation are:

- U.S. population (a proxy for the number of potential drivers)
- real national income
- product price (regular leaded gasoline at full service outlets)

By using projections of future levels for these variables in the demand equations, the model generates estimates of future petroleum product demands. For this analysis, projections of most future macroeconomic activity were obtained from Data Resources, Inc. (DRI). These include real national income, GNP price deflator, product prices, index of national electric power generation, index of national chemical industry output, and federal goverment purchases for national defense. These variables for the most part are required for the non-gasoline product projections.

DRI's projections for each of these variables are determined as part of their macroeconomic simulations of the United States. These simulations, run monthly for short-term projections and quarterly for long-term projections, are based on alternative assumptions about future economic prospects. The population projection is not influenced by the economic environment.

Economic Assumptions

Projections of the demand for motor gasoline used in this analysis are based upon three macroeconomic scenarios ranging from optimistic to pessimistic for future economic growth. 3/ The principal energy demand factors imbedded in these forecasts are listed in Table 1.

For this analysis the assumption was made that product prices would remain constant in real terms. The assumption that prices will rise only in accordance with the rate of inflation appears within the bounds of recent historical

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3/ DRI's OPTIM0525, CONTROL0524 and PESSIM0524, respectively.

TABLE 1

PRINCIPAL ASSUMPTIONS UNDERLYING THE PETROLEUM PRODUCT DEMAND FORECASTS

	1978	1979	1980
Real GNP: Annual Growth rate (%)			
OPTIM	4.4	4.0	5.0
CONTROL	4.0	3.6	4.8
PESSIM	3.1	2.6	4.8
GNP Deflator (inflation rate in %) a/			
OPTIM	6.2	5.6	6.0
CONTROL	6.6	6.2	6.5
PESSIM	6.9	7.0	7.4
Real National Income (growth rate in %) a/			
OPTIM	5.4	4.0	5.2
CONTROL	5.0	2.7	5.0
PESSIM	3.8	1.5	5.1
Index of Chemical Industry Activity b/			
OPTIM	1.92	2.10	2.30
CONTROL	1.92	2.04	2.23
PESSIM	1.88	1.98	2.17

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a/ Measured from mid-year to mid-year.

b/ Mid-year value.

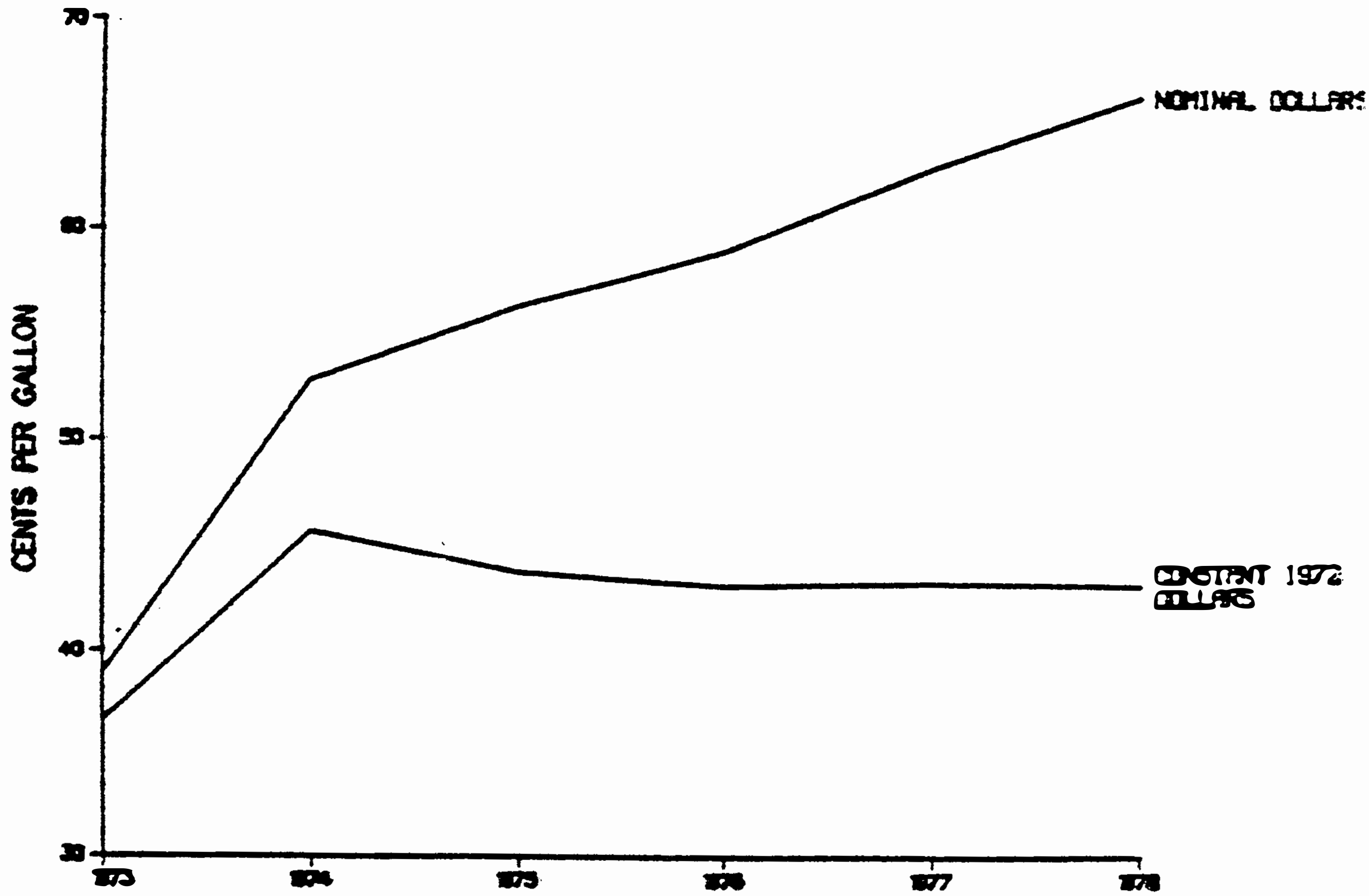
observations. For example, Figure 1 shows recent trends for the price of leaded regular gasoline at full service outlets. This shows relatively constant real prices over the last four years. There is a possibility of modest price increases in the price of gasoline over the next few years due to the recent DOE "tilt" proposal which allows refiners to allocate increased production costs to gasoline prices on a greater than pro rata volumetric basis and also allows retailers to increase prices.

Conservation Estimates

The estimates obtained from the STPPDFM do not capture structural changes in demand which were not observed during the period over which the model was estimated. Such a structural change is expected to occur due to the mandated new car efficiency standards set forth in the Energy Policy and Conservation Act. These standards will lead to gradually, but significantly increasing automobile fleet efficiencies that are not embodied in the econometric estimates of the STPPDFM. Over the period of time the STPPDFM was estimated, the automobile fleet efficiency

FIGURE 1

RETAIL GASOLINE PRICE
(LEADED REGULAR AT FULL SERVICE OUTLETS)



SOURCE: DOE Monthly Energy Review. 1978 point estimat d from data for the first three quarters.

	Nominal	Constant (72)
1973	39.0	36.7
1974	52.8	45.7
1975	56.2	43.7
1976	58.7	43.1
1977	62.6	43.2
1978	66.0	43.1

was essentially constant at approximately 13.6 miles per gallon. To correct for this limitation, the demand forecasts produced by the STPPDFM are adjusted downward by estimates of conservation obtained from the Light Duty Vehicle Fuel Consumption Model (LDVFCM). 4/

The LDVFCM is a structural model which derives fuel consumption from past and projected characteristics of the vehicle fleet. These characteristics are: annual new vehicle registrations, scrappage rates, vehicle miles traveled per vintage car year, new vehicle average fuel economies as determined through EPA test procedures, and on-road miles per gallon (mpg) discount factors which account for in-use driving conditions, thereby reducing fuel economy below the EPA test value. Through a series of accounting computations, the fleet vehicle miles traveled, the mpg of the fleet, and the fleet fuel consumption are derived. In addition, estimates of dieselization (the increasing use of diesel fuel in passenger cars and light duty trucks) are also obtained. The LDVFCM estimates the

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4/ For a description of the model see Light Duty Vehicle Fuel Consumption Model, April 28, 1978, Energy and Environmental Analysis, Inc.

consumption of motor gasoline and diesel fuel by passenger cars and light trucks and vans. These vehicles are subject to the standards set forth in the Energy Policy and Conservation Act.

The procedure for adjusting the demand forecasts provided by the STPPDFM is to run the LDVFCM under two scenarios. One scenario simulates the conditions of the STPPDFM where total fleet efficiency is held constant at 13.6 mpg. The other scenario is run under the assumption that new vehicle fuel efficiency standards are met, implying an increase of overall vehicle fleet efficiency over time. The difference in total fuel consumption between these two scenarios is an estimate of the conservation savings due to the new vehicle fuel efficiency standards. These savings are then subtracted from the demand forecasts derived from the STPPDFM. In 1980 these conservation savings amount to between 430,000 and 730,000 barrels per day, depending on the on-the-road efficiency assumptions described in the next section. Increased diesel fuel use between the two runs of the LDVFCM are also subtracted from the gasoline requirements but are added to the distillate estimates from the STPPDFM. In 1980, this increased diesel use is relatively insignificant, on the order of 35,000 barrels per day.

EPA Test Vs. On-Road New Vehicle Fuel Economy

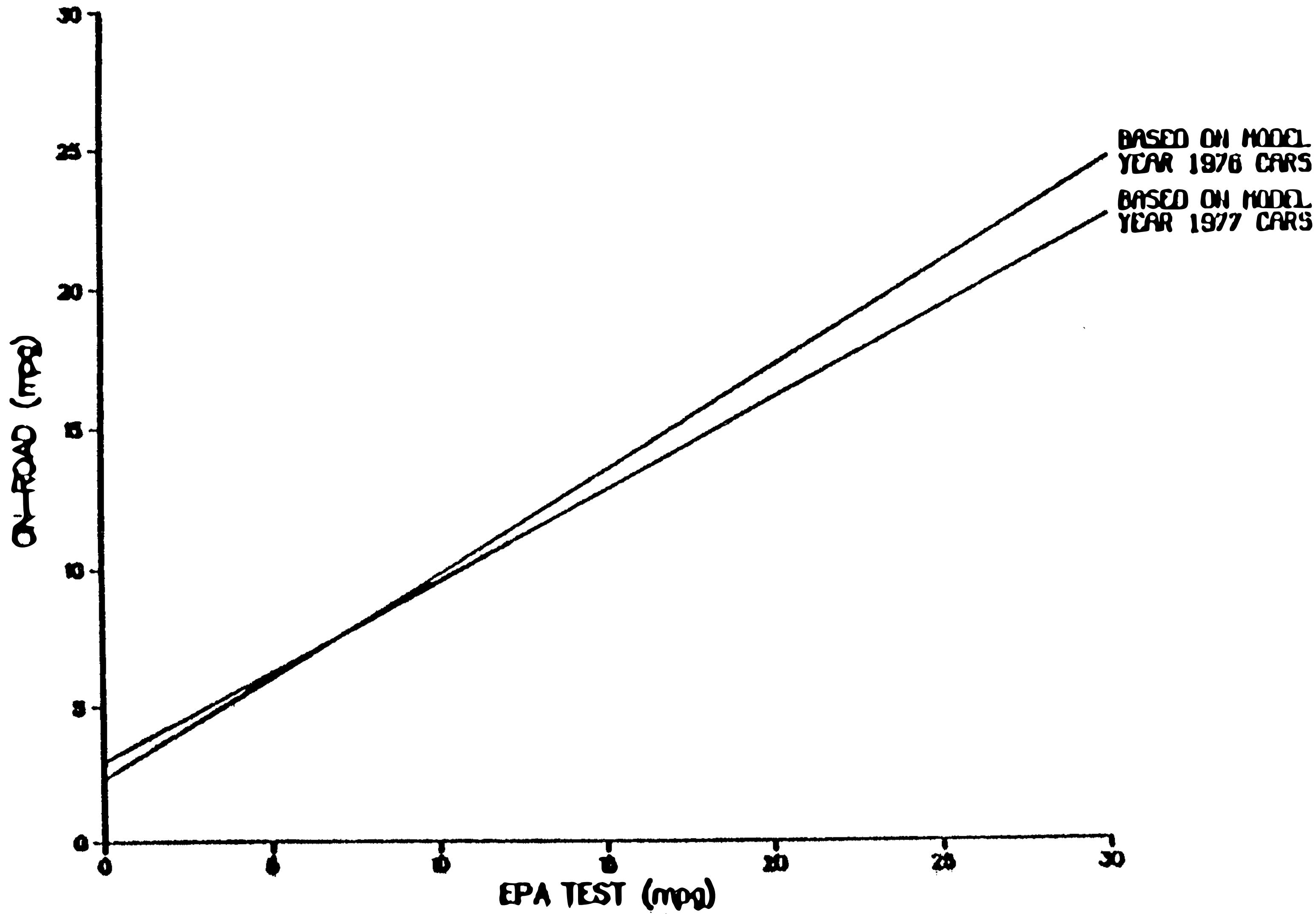
The existing and future relationship between EPA test and on-road fuel economy of new vehicles is a factor that introduces a significant amount of uncertainty into the estimation of energy consumption in the transportation sector. The LDVFCM calculates energy consumption under the assumption that there will be a degradation between fuel economy tests on new vehicles and actual on-road experience. Based on the evidence to date, there is a significant difference between on-road performance and the EPA test results. 5/ However, there is uncertainty as to the precise amount of this degradation. For this analysis, degradation relationships determined from experience on selected samples of model year 1976 and 1977 automobiles were used. Figure 2 shows a graph of these two relationships. As an example, 1976 vehicles with EPA test results of 25.0 mpg are estimated to perform at 20.8 mpg and 1977 vehicles at 19.2 mpg. The test results are based on records from large automobile fleets. 6/

5/ See McNutt, Barry et.al., A Comparison of Fuel Economy Results from EPA Tests and Actual In-Use Experience, 1974-1977 Model Year Cars, February, 1978.

6/ The 1976 relationship is based on observations of 138 different car model/engine type combinations while that for the 1977 automobiles covered 58 combinations.
The estimated relationships are:
Model Year 1976: On-road mpg = 0.74 x EPA Test mpg + 2.32
Model Year 1977: On-road mpg = 0.65 x EPA Test mpg + 2.98.

FIGURE 2

DEGRADATION RELATIONSHIPS BETWEEN EPA TEST AND ON-ROAD FUEL ECONOMY



If it is assumed that total vehicle miles are insensitive to the severity of this degradation, then significant variations in vehicle fuel consumption will occur when different degradation relationships are used in the LDVFCM.

Demand Projections

Table 2 shows the range of motor gasoline demand forecasts for the three macroeconomic and two conservation scenarios assuming constant real prices. The first and last values in each column represent the extreme cases in each year. Optimistic macroeconomic assumptions combined with low conservation estimates produce the high end of the range, while pessimistic macroeconomic assumptions combined with high conservation savings produce the low end of the range. Figure 3 shows a graph of these demand projections, as well as the historical data for the period 1972 to 1978.

Table 3 presents the conservation and dieselization estimates derived from the LDVFCM which were used to adjust the demand forecasts produced by the STPPDFM.

TABLE 2

MOTOR GASOLINE DEMAND ESTIMATES
1978-1980
(MB/D)

Macroeconomic Forecast/Level of Conservation:	Actual	Estimated		
	1977 a/	1978 b/	1979	1980
OPTIM				
Low Conservation	7176	7395	7769	7962
High Conservation	7176	7395	7509	7662
CONTROL				
Low Conservation	7176	7395	7740	7928
High Conservation	7176	7395	7480	7628
PESSIM				
Low Conservation	7176	7395	7697	7884
High Conservation	7176	7395	7437	7584

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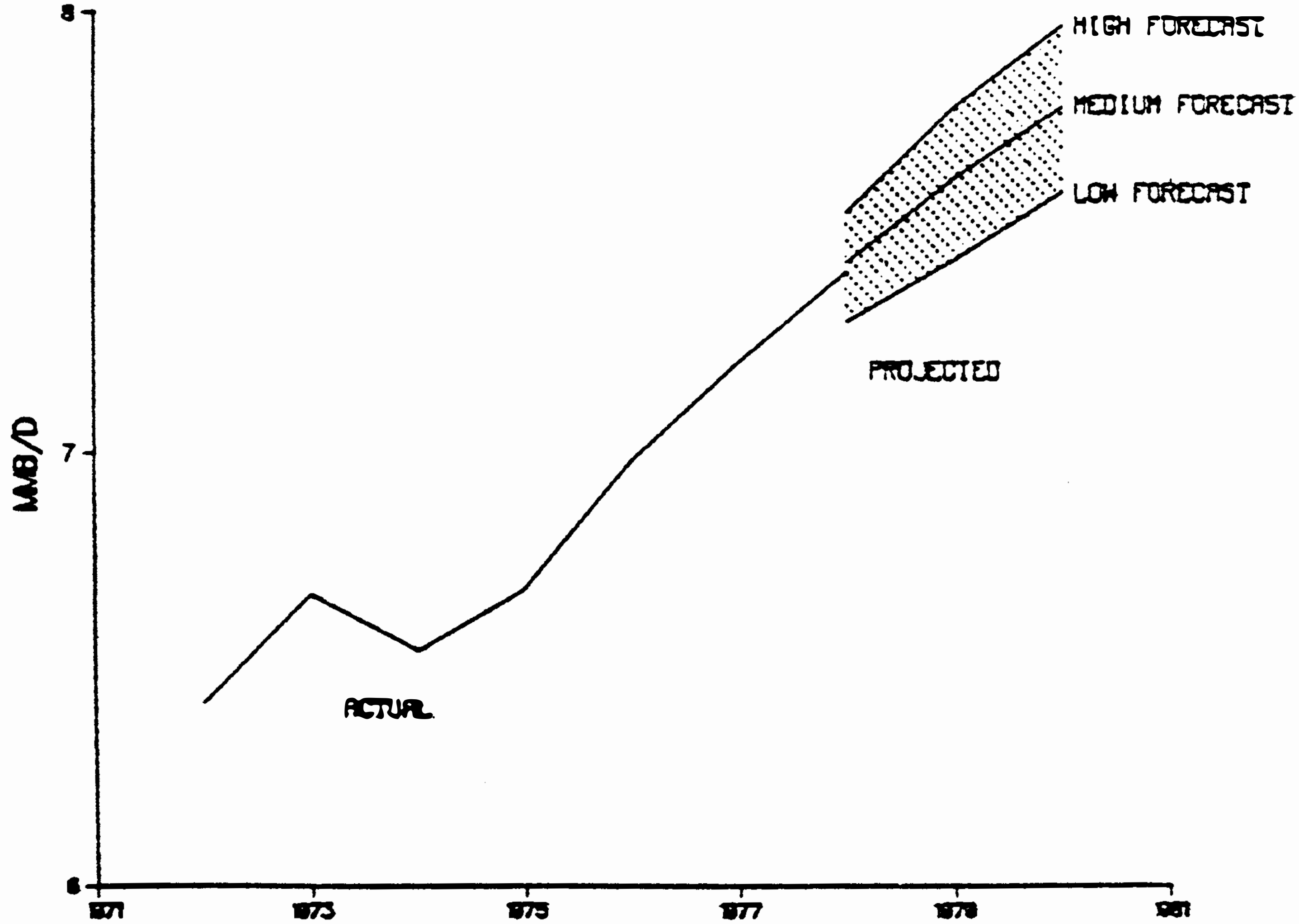
a/ Source: Monthly Energy Review, EIA.

b/ Based on 10 months preliminary data from EIA.
See footnote to Figure 3 for a further explanation.

FIGURE 3

DOMESTIC MOTOR GASOLINE DEMAND



* Actual data were taken from the DOE <u>Monthly Energy Review</u>. The 1978 point was estimated from data for the first three quarters by proportionment to comparable 1977 data as follows:

MB/D	1977	1978
3 Quarters	7,157	7,375
Full Year	7,176	7,395 (est.)
Ratio	1.003	(same)

TABLE 3

RANGE OF MOTOR GASOLINE CONSERVATION ESTIMATES
1979-1980
(MB/D)

	1979	1980
Current Estimates a/		
Low Conservation b/	250	430
High Conservation c/	510	730
Increased Distillate Consumption Due to Dieselization	15	35

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a/ These estimates differ from those used in the EIA Analysis Memorandum (AM/ES/78-19) "Motor Gasoline Supply and Demand through 1980," August 1978. The earlier conservation estimates correspond to the high conservation case, but were based on higher automobile sales and projected higher average new car EPA-test mileage.

b/ Based on the relationship between EPA-test and on-road fuel economy developed from the experience of 1977 model year automobiles.

c/ Based on the relationship between EPA-test and on-road fuel economy developed from the experience of 1976 model year automobiles.

SUPPLY ASSUMPTIONS

The supply analysis evaluates the ability of the domestic refining industry to meet the projected demands for leaded and unleaded gasoline in 1980. In this analysis, a composite U.S. refinery model was used to estimate the potential supply of motor gasoline, given the constraints of projected demands, capacities, product qualities and EPA lead level restrictions.

This methodology develops estimates of refining capacity requirements for supplying the forecast demand for motor gasoline given different assumptions on refinery operating conditions. These estimates of capacity requirements are then compared with projections of available refining capacity. Any potential capacity shortfalls are subsequently identified and used to estimate potential gasoline supply under each set of assumptions.

This section first provides a brief description of the gasoline production processes. Next, gasoline production as impacted by the restrictions proposed by the Environmental Protection Agency on the use of octane boosting additives is discussed. And finally, a brief description of the model which was used to analyze domestic refining activities, and specific assumptions made are presented.

Gasoline supply estimates from alternate refinery simulations are presented in the following section on the 1980 supply and demand balance. That section also presents a discussion of the potential supply enhancements resulting from adjustments to refinery capacity utilization rates, use of allowed octane boosting additives, and a certain amount of octane quality reduction. The base case described here is not presented, however, as a "most likely" situation, but rather as a logical departure point for evaluating the potential contribution to gasoline supply of several production strategies which may be pursued by the refining industry.

Refining Capacity Requirements

Gasoline demand can be satisfied by domestic refinery output, imports, and, in the short-run, by inventory drawdowns. This analysis initially assumes a restrictive production environment. Imports are assumed constant at a relatively high but feasible level and inventories are not built up or drawn down on an annual basis.

1. Gasoline Manufacturing Processes - A refinery consists of a number of processes for separating, changing and blending crude oil components. As described below, principal refinery processing operations which yield outputs blended to make gasoline include crude oil distillation, catalytic cracking, hydrocracking, catalytic reforming, alkylation, and isomerization. The available capacity of these and other processing

units 7/, the rates and conditions at which they are operated, and the quality of crude oils processed essentially determine the refinery yield of gasoline.

- Crude Distillation - Components of crude oil are separated based on their boiling points, which can range to well over 1000 degrees Fahrenheit. Light components of crude (which may be blended or further processed to make gasoline and are sometimes referred to as naphthas) have lower boiling points (100-400 degrees). High API gravity crudes generally have a higher percentage of low boiling point components and have a higher gasoline yield potential.

- Catalytic Cracking - This is the primary method for increasing the yield of gasoline from crude. In this process the large molecules of distillate oils (generally 550 to over 700 degrees boiling range) are "cracked" into smaller molecules. The process yields gasoline and naphthas, some of which are ready for final blending.

- Hydrocracking - Again cracking of large molecules is the objective, only in this process, hydrogen must be present. Unlike catalytic cracking, a wide range of feedstocks can be used in this process (from middle distillates to heavy oils) and it does not produce a high yield of low utility, high boiling by-products. The process yields gasoline and naphthas. Hydrocracking is a relatively expensive process in terms of both capital and operating costs and its use is not as widespread as that of catalytic cracking.

7/ Other gasoline producing equipment include cokers and polymerization units.

- Catalytic Reforming - This is the primary method for increasing the octane quality of potential gasoline blend stocks. Naphtha not suitable for finished product (principally low octane components) are chemically changed in order to improve their octane characteristics. The high octane material from this process is called reformate. Important determinants of the reformate yield are the conditions--pressure, temperature, etc., (referred to as the severity of operation)--under which the reaction is carried out. Increasing severity increases the octane number of the reformate, but lowers yield by converting some of the charge stocks to gas.

- Alkylation - The alkylation process combines light, selected by-products of the catalytic cracking process (butylene and propylene) with isobutane to synthesize high octane gasoline blendstocks called alkylates. Like hydrocracking, the alkylation process is relatively expensive compared to other refinery processes for manufacture of high quality gasoline blendstocks.

- Isomerization - In this process, low octane normal butanes, pentanes or hexanes are converted into high octane isomers. Isomerization is a relatively expensive process compared to catalytic reforming, and like alkylation its utility may be limited by feedstock availability.

Finally the many gasoline component streams are blended, either in-line, in the piping network within the refinery or in tank farms neighboring the plant. The objective here is to combine the various blend stocks from the processes mentioned above in the proportion which satisfies all product quality specifications. These include most importantly, research and motor octane number and vapor pressure.

Additional factors affecting the refinery yield of gasoline are the restrictions on octane improvement additives used in the blending phase, such as tetra-ethyl lead (TEL) and MMT (a manganese compound used by the industry to boost gasoline octane ratings).

2. Regulatory Environment Concerning Gasoline Additives - Since 1975 American auto manufacturers have equipped most passenger cars with catalytic converters in order to reduce harmful emissions. Tetra-ethyl lead deactivates the catalyst in the converters, raising the level of harmful emissions. Hence, these automobiles must use unleaded fuel. As the demand for unleaded gasoline increases, the octane requirements for gasoline blending components will also increase (in order to compensate for the loss of incremental octane rating formerly supplied by lead additives).

The octane requirements of gasoline blending components will be further increased by two recent decisions by the EPA. First, the use of MMT for gasoline octane improvement is prohibited in unleaded grades, effective September 1978, again because of the possibility of catalyst deactivation in vehicles equipped with converters. Second, the EPA has established an October 1, 1979, phasedown schedule of 0.5 grams per gallon (g/gal.) as the maximum lead concentration allowed in the U.S. gasoline pool (total lead used divided by total gasoline produced).

This phasedown forces refiners to reduce the average lead level level of their leaded gasoline earlier than would be accomplished by "natural phasedown" (a consequence of the increasing share of unleaded gasoline in the overall gasoline pool because of the replacements of older cars by new cars using lead-free gasoline). Consequently, the clear octane quality of leaded gasoline blending stocks must increase to compensate for this loss of lead. Currently and into early 1979, according to the EPA phasedown schedule, the maximum lead content in gasoline should be .8 g/gal. However, EPA has temporarily waived this requirement for many refiners. Refiners granted waivers account for about 80 percent of U.S. domestic gasoline production capacity. Small refiners are granted additional exemptions from the lead level requirements. Thus, the level of lead in motor gasoline is expected to average 1.2 grams per gallon in 1979 and 0.59 grams per gallon in 1980 unless further waivers are granted.

3. Refinery Model and Assumptions - As indicated in the previous section, the petroleum industry will need to increase its yield of high clear octane gasoline blending components significantly by 1980 in response to increased demand for unleaded fuel and restrictions on additives.

A model of the aggregate U.S. refining industry was used for the analysis. The model was constructed with technical data on refinery operations from the Bonner and Moore Refinery and Petrochemical Modeling System (RPMS). The RPMS model is a comprehensive simulation of refinery operations in which crude distillation, downstream unit operations and product blending are mathematically represented. The model treats the United States as a composite of all refineries simulating actual operations by selecting a least cost method of converting crude oils to finished petroleum products using existing refinery facilities, or by constructing new capacity

The RPMS data base consists of individual crude assays, process yield correlations, refinery capacity and configuration data, investment data and operating costs. RPMS investment data represents current Gulf Coast construction costs for each type of refinery processing unit.

The RPMS model was formulated to reflect assumptions concerning future product demand, product imports, refinery unit capacities and operating rates, and use of octane boosting additives. Capacities are set at projected levels for all refinery processing units except catalytic reformers, in which the model allows additional "investment" to meet increased demands for high octane components. As lead is removed from gasoline, octane ratings can be maintained only by upgrading relatively low quality blendstocks by more intensive processing, primarily catalytic reforming.

Specific assumptions made in this analysis include the following:

- Future gasoline demands - High and low demand projections as presented in the first section of this paper. Other product demands were not varied but held at the midrange level as forecast by the STPPDFM in percentage yield terms.

- Gasoline imports - Imports are assumed to be available at an average 300 thousand barrels per day (MB/D), with 60 MB/D being unleaded regular gasoline and 240 MB/D being leaded regular gasoline.

- Capacities of refinery processing units - Capacities for crude distillation and other major gasoline producing units are shown below. The data has been compiled using actual data submitted to the Department of Energy for the 17 largest gasoline refiners and published data for the remaining refiners.

	1980 Capacity Thousand Barrels Per Stream Day
Crude Distillation	18,117
Catalytic Reforming	4,084
Catalytic Cracking	5,232
Hydrocracking	895
Alkylation	936
Isomerization	179

Of the total available catalytic reforming capacity, 309 MB/D in 1978 and 374 MB/D in 1980 were estimated to be dedicated to the production of aromatic petrochemicals.

- Capacity Utilization Rate - Downstream refinery units were initially assumed to be operated at 92 percent capacity utilization. The utilization rates were subsequently varied to 94 percent as a means of increasing gasoline supplies. Crude distillation capacity is specified not to exceed 91 percent.

- Use of lead and MMT - Average lead level in 1980 is evaluated at the EPA October 1979 phasedown level of 0.5 grams per gallon and alternatively at 1.2 grams lead (in the event that the EPA would grant additional waivers). Because of the small refiner exemptions, the effective concentration is 0.59 at the 0.5 grams level. Use of MMT in leaded gasoline only is evaluated as an alternative to increase gasoline supplies.

- Octane boost available from lead and MMT - The current source of data concerning the octane boost available from various MMT manganese concentrations is the Ethyl Corporation, the sole manufacturer of MMT. Estimates from EPA based on Ethyl Corp. data indicated that a manganese concentration of 0.024 g/gal would provide 0.26 RON and 0.26 MON octane increase in the leaded premium and regular grades. 8/

The lead/octane representation in the RPMS model is also from the Ethyl Corporation. The model fully tracks the nonlinearities associated with gasoline octane blending. Because of changes in the composition of gasoline in the different cases, the assumed pool octane response is automatically recalculated by the model for the new blend. A representative approximation to the lead response curves is presented in the following table:

8/ RON refers to Research Octane Number, a laboratory rating, and MON refers to Motor Octane Number, a rating of actual engine anti-knock performance. (R+M)/2 refers to the average of RON and MON.

Lead Octane Response

Concentration grams lead/gallon	Octane Boost a/ Premium RON	Premium MON	Regular RON	Regular MON
0 (clear)	0	0	0	0
0.5	3.1	6.0	3.5	4.0
1.0	5.2	8.5	6.1	6.1
1.5	6.6	9.9	7.7	7.4
2.0	7.5	11.1	8.7	8.4
3.0	8.9	12.6	10.2	9.7

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a/ See footnote on page 27.

- Market Shares of Gasoline Grades and Octane Specifications - The market shares of the various grades of gasoline assumed in the study are shown below. Imports from abroad were assumed to be 20 percent unleaded regular and 80 percent leaded regular gasoline, so refinery production shares for unleaded grades were adjusted upward accordingly. Gasoline specifications other than octane (vapor pressure, boiling point, volatility, etc.,) were set at current industry averages.

1980 Market Shares of Gasoline

	Base a/ Assumption	Alternate b/ Assumption
Unleaded Regular	50%	34%
Unleaded Premium	Negligible	18%
Leaded Regular	42%	44%
Leaded Premium	8%	4%

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a/ Estimated by EPA, based on Ethyl Corp. data.

b/ This assumption is discussed in the following text.

The RON (Research Octane Number) and MON (Motor Octane Number) quality specification were set as follows:

Gasoline Octane Specification

	Base Assumption		Alternate Assumption	
	RON	MON	RON	MON
Unleaded Regular	92.3	84.0	91.5	82.5
Unleaded Premium	--	--	93.4	86.0
Leaded Regular	93.4	86.0	93.4	86.0
Leaded Premium	98.9	91.5	98.9	91.5

The base assumptions on grade split and qualities have been used in earlier analyses and have been estimated by the EPA.

In the alternate assumption, leaded premium sales are assumed to be reduced from 8 percent of the total to 4, with 2 percent going to leaded regular sales and the other 2 percent to unleaded premium. The unleaded premium pump octane quality is assumed to be equal to that of leaded regular and the unleaded regular pump octane is reduced to the EPA minimum of 87 (R+M)/2 from the current quality of about 88.2 (R+M)/2. The unleaded gasoline pool is assumed to be about one-third unleaded premium and two-thirds unleaded regular. This assumption, in effect, can be considered a possible marketing strategy which could reduce overall octane demand.

1980 MOTOR GASOLINE SUPPLY AND DEMAND BALANCE

This section presents estimates of potential gasoline supply which would be available in 1980, given alternate assumptions regarding refinery utilization rates, use of octane boosting additives, and product quality. The analysis, however, assumes the refining industry will take all steps necessary to ensure an adequate supply in 1980. Accordingly, intermediate supply estimates are presented only to facilitate evaluation of the potential impact of the supply enhancing measures considered here. No conclusions should be drawn from non-balancing supply and demand estimates other than as provided in this analysis.

The most significant limitation on gasoline supplies in 1980 will be the ability of domestic refiners to produce sufficient quantities of high octane gasoline to replace octane boosting capability formerly provided by lead and MMT additives. The critical refinery process for increasing octane is the catalytic reforming. The catalytic reforming process yields high octane streams called reformates, which are blended to make gasoline or processed further to yield aromatics which are used as feed-stocks by the petrochemical industry. The amount of reforming capacity needed as other options available to refiners were varied, was obtained from the alternate RPMS model simulations. Subsequently, required reforming capacities were compared to available capacities to determine the range of potential gasoline production under the various alternatives. This was accomplished by comparing incremental gasoline production and incremental reforming capacity availability established in each simulation. Estimated gasoline production levels obtained in this manner are presented in Table 4 for six cases representing different combinations of options available to U.S. refiners to increase the gasoline yield. Tables 5 illustrates the octane ratings obtained under the different case restrictions. In Table 6 potential gasoline production is added to imports to yield potential total supply, which is then compared with forecast demand.

The data in Table 4 indicate that the domestic refinery gasoline production capability ranges from 7,160 MB/D to a maximum of 7,662 MB/D and varies with assumptions regarding refinery capacity utilization, use of MMT in leaded grades, the option of slight octane reduction in leaded grades, introduction of two grades of unleaded gasoline to reduce the unleaded octane requirements, and finally use of estimated 1979 levels of lead in the gasoline pool. Case A shows the most restrictive set of assumptions modeled. Cases B-F show alternative combinations and magnitudes and their incremental supplies over those of Case A.

The combinations of the factors varied in this analysis and their respective magnitudes should not be interpreted as the sole set of supply alternatives. These cases are merely representative of the spectrum of possibilities, and are used to demonstrate the relationships between motor gasoline supply and the options varied. Similarly, the refining industry may not be compelled to invoke the measures presented in either the exact combinations or magnitudes as represented by the six cases in Table 4.

Table 5 identifies the pool octane ratings that correspond to the six cases presented in Table 4, showing the effect of the various options choosen. Pool octane ratings would vary as combinations and magnitudes of options varied.

TABLE 4

1980 DOMESTIC MOTOR GASOLINE PRODUCTION ALTERNATIVES

	Case A	Case B	Case C	Case D	Case E	Case F
Estimated Gasoline Production, MB/D	7,160	7,265	7,284	7,454	7,662	7,662
Options Varied						
Capacity Utilization Percent	92	94	92	94	94	92
MMT in Leaded Grades	NO	NO	YES	YES	YES	NO
Octane Shaving in Leaded Grades	NO	NO	YES	YES	YES	NO
Two Grades of Unleaded (reduction in pool octane)	NO	NO	NO	NO	YES	NO
Pool Lead Average, g/gal	0.59	0.59	0.59	0.59	0.59	1.20

TABLE 5

OCTANE RATINGS OF PRODUCTION ALTERNATIVES

	Case A	Case B	Case C	Case D	Case E	Case F
Pool Average Pump Octane Produced (R+M/2)	90.0	90.0	89.76	89.71	89.26	90.11
Pool Average Clear Octane Produced (R+M/2)	86.90	86.66	86.66	86.65	86.28	85.54

TABLE 6

1980 MOTOR GASOLINE SUPPLY/DEMAND BALANCE

Supply/Demand (MB/D)	Case A	Case B	Case C	Case D	Case E	Case F
Estimated Production (From Table 4)	7160	7265	7284	7454	7662	7662
Imports	300	300	300	300	300	300
Total Supply	7460	7565	7584	7754	7962	7962
Low Demand	7584	7584	7584	7584	7584	7584
High Demand	7962	7962	7962	7962	7962	7962

Table 6 compares the total supply of motor gasoline available, including imports of 300 MB/D, under each set of assumptions concerning refinery operating conditions with the high and low demand forecasts. As shown in that table, the addition of 300 MB/D of imported gasoline to the alternative levels of gasoline which could be produced by domestic refiners is sufficient to satisfy even the extremely high levels of demand which are projected if the economy were strong and automobile efficiency were low.

When comparing the various supply alternatives to the range of projected demands for possible balance combinations, the reader is again reminded that the cases presented are not exhaustive of the supply and demand possibilities but are merely "snapshots" of various points along the supply and demand curves. It is assumed that the refining industry would combine the various options to arrive at a supply that would satisfy the actual demand. However, low demand forecasts by the refiners in conjunction with higher actual demands could result in supply deficiencies.

Details of the alternate options to increase supply that would be available to the refiners are discussed below:

1. Capacity Utilization - Capacity utilization rates of 92 and 94 percent for principal gasoline processing operations are evaluated in Cases A and B of Table 4. (These rates are distinguished from the utilization rate

for crude distillation capacity, which does not exceed 91 percent). In varying the capacity utilization rates, it is assumed that although no new capacity other than those already announced additions will be available to refiners, it may be possible to increase the utilization rates of existing downstream refinery units to provide about 100 MB/D additional supply and increase total gasoline production from 7,160 MB/D in Case A to 7,265 MB/D in Case B.

2. MMT in Leaded Grades/Octane Shaving in Leaded Grades Although use of the MMT additive is prohibited by the EPA in unleaded grades, this additive may be used by refiners in leaded grades to increase the octane rating of low octane components of the gasoline pool.

   Additionally, it may be practical to assume a decrease of an average of 0.2 octane numbers ((R+M)/2) in the octane rating of leaded gasolines in order to increase the availability of gasoline supplies. The reasonableness of this assumption is supported by the observation of historical declines in the pump octane quality for leaded grades of gasoline. According to the DuPont Road Octane Survey of Summer 1977, "premium grade octane qualities (across the U.S.) have generally declined about one octane number since 1973." Likewise, in the East Coast, Gulf Coast, North Central and West Coast markets, the octane quality of leaded regular grade appears to have declined about one octane number between 1971/72 and 1976.

   The effect of using MMT in leaded grades and reducing the octane quality of the leaded grades by 0.2 octane numbers is presented in the comparison of Cases B and D for the 94 percent capacity utilization assumption. At 94 percent capacity utilization, an increase of 189 MB/D in gasoline supplies is achieved. At 92 percent capacity utilization, gasoline supplies would be increased by 124 MB/D.

3. Two Grades of Unleaded - As the need to increase the clear octane rating of the gasoline pool increases because of lead phasedown and the increasing share of unleaded in the pool, some refiners may decide to redistribute the use of their clear octane capability by eliminating their leaded premium gasoline production and instead providing one grade of leaded gasoline and two grades of unleaded. The variations in the grade split and qualities occasioned by this scenario were discussed in an earlier section. This scenario is evaluated in Case E of Table 4 and indicates that over 200 MB/D additional gasoline supply may be provided by reducing the leaded premium sales and introducing two grades of unleaded gasoline.

4. Continuation of EPA Lead Phasedown Waivers - As indicated in Case F, about 500 MB/D gasoline supply may be obtained over Case A levels by assuming a continuation of the EPA lead phasedown waivers as in 1978 and 1979. Until recently, the EPA lead phasedown had been discussed in the context of a decrease in the rate of growth of gasoline consumption in the 1978-1980 period eventually leading to a leveling off in the overall consumption. However, the current analysis was performed against a background of sharp upward revisions of the 1980 motor gasoline demand.

CONCLUSION

In this analysis no attempt has been made to identify the most probable course for the economy or to predict the actions of either the Environmental Protection Agency or the refining industry in general. The analysis, however, has included a range of demands which should encompass the actual 1980 levels, and has evaluated the capability of the refining industry to satisfy the range of demand projections. While some adjustments by the industry will be required to satisfy even the low demand level in 1980, the high range of demand projections can only be satisfied with a combination of product imports and major adjustments by U.S. refiners.

APPENDIX G

Department of Energy
Washington, D.C. 20461

ANALYSIS MEMORANDUM

AM/ES/79-17

MOTOR GASOLINE PRICES THROUGH 1980 UNDER CONTINUED DOE PRICE CONTROLS

All forecasts and analyses presented in this paper are conditional, based on clearly specified assumptions in areas of legitimate real world uncertainty. Reference to these forecasts out of context is inappropriate and may be misleading.

Richard Farmer

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Office Energy Source Analysis

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PREFACE

This analysis was undertaken in response to a request from the Economic Regulatory Administration (ERA) for an evaluation of expected trends in refiner`s costs and gasoline prices under continued DOE price controls. Similar evaluations performed in the past by the EIA have been referenced in ERA regulatory analyses supporting proposals to decontrol motor gasoline prices.

The author of this paper wishes to thank Bill Maher, Ercan Tukenmez and Rebecca Clem for their assistance in the preparation of this paper. The analysis was performed under the general supervision of David T. Hulett and Charles G. Everett. Secretarial assistance was provided by Lillian Roberson.

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EXECUTIVE SUMMARY

This memorandum presents a range of motor gasoline price increases allowable both under current DOE pricing rules and with the proposed "gasoline tilt" ruling, and evaluates the flexibility refiners have in setting prices under controls.

The analysis uses EIA's Short-Term Petroleum Cost Distribution Model (STPCDM) to project price increases and refiner s banks of unrecouped costs. The STPCDM models DOE pricing rules in adding projected allowable cost increases to a base period price.

Projections of gasoline prices and refiners' banks of unrecouped costs are shown to vary with (1) economic growth and inflation and (2) the proportion of maximum allowable costs actually passed through to prices. These banks may be used to support price increases in excess of current cost increases.

The analysis indicates:

- 1979 OPEC crude oil price hikes will increase refiner costs and, subsequently, gasoline prices by less than three cents per gallon.

- Continuation of current DOE rules allowing pro rata volumetric passthrough of costs could constrain prices to levels lower than would be expected if prices increased with inflation (even when the impact of the OPEC increase is included).

- A proposal to allow greater than volumetric passthrough (gasoline tilt) would permit retail prices to be increased at a higher rate than general inflation.

- The 1979 OPEC price increase, if not followed by a 1980 increase, will not result in 1980 gasoline prices significantly different from the case where imported prices continue to increase with U.S. domestic inflation over that period.

- Under current DOE pricing rules, attempts by refiners to increase retail prices at the same rate as general inflation by drawing down banks of past unrecouped costs would result in unprecedented low bank levels by the end of 1979. These banks may be used to increase prices in excess of current cost increases. If a tight gasoline supply situation were to develop in 1980, refiners would have little or no pricing flexibility to deal with excess demand.

INTRODUCTION

This Analysis Memorandum evaluates trends in nominal retail gasoline prices allowable under continued DOE crude oil and refined product price controls. Allowable price increases are projected under a low and a high gasoline demand scenario, as well as under alternate assumptions regarding the level of refiners` costs actually passed through to prices. In addition to the presentation of a range of price increases allowable through 198Ø a second objective of this study is the evaluation of the flexibility refiners have in setting gasoline prices under controls. Thus the study also discusses the relationship between refiners banks of unrecouped costs (past cost increases allowable under DOE rules which have not yet been recouped, but which may be recovered in present gasoline prices) and the determination of ceiling prices. DOE pricing rules for gasoline are described in Figure 1 and discussed in more detail in the section on motor gasoline banks.

The analysis utilizes EIA`s Short-Term Petroleum Cost Distribution Model (STPCDM), which allocates projected increases in refiners` crude oil and nonproduct costs to refined product prices. Price increases expected if gasoline prices move with the general rate of inflation are compared both with the estimated increases allowable under existing pricing rules and with price increases which would be allowable with the recently proposed "gasoline tilt" ruling.

Also using the STPCDM, refiners` banks of unrecouped costs of producing gasoline through 1979 are analyzed. The existence of large gasoline banks has been presented in previous analyses as evidence that market forces are constraining refiners from passing through all cost increases to product prices. In this study the relationship between projected bank levels and the degree of constraint on refiner s pricing behavior is evaluated.

OVERVIEW OF SHORT-TERM PETROLEUM COST DISTRIBUTION MODEL (STPCDM) AND ECONOMIC ASSUMPTIONS

The STPCDM is used here to evaluate trends in gasoline prices under alternate assumptions of low and high economic growth, as presented in the EIA Analysis Memorandum "1980 Motor Gasoline Supply and Demand" (AM/ES/79-12). In those macroeconomic scenarios the low economic growth case is characterized by higher inflation than the high growth case. Demand projections and key macroeconomic variables consistent with that Analysis Memorandum and used in the SPTCDM are summarized in Table 1 of this report. Additional scenarios evaluate the impact of increased OPEC prices and of proposed changes in DOE pricing rules.

In the STPCDM, refiners` total cost increases over a base period cost are added to a base period refined product price, as specified in DOE pricing rules. This total cost includes projections of refiners` composite crude oil cost (aggregating major crude oil cost categories), imported product costs, and nonproduct costs. In the basic low and high growth scenarios analyzed here, prices of imported crude, uncontrolled domestic crude and imported refined products are assumed to increase through 1979 according to the same schedule as that announced for OPEC nations, and to remain constant in 1980. An additional scenario evaluates the potential impact of a further OPEC price increase in 1980. Controlled domestic crude oil prices in all scenarios are assumed to be inflated quarterly by the implicit GNP price deflator, as specified in DOE pricing rules. Projected volumes for these cost elements from the STPCDM are used to derive a weighted average product cost increase for refiners. Refiners' nonproduct cost increases are estimated by inflating historical refiners' gross margins (refinery gate price minus average crude oil cost) quarterly with the GNP price deflator. Distributor price margins are assumed in this analysis to remain constant.1/ (Arithmetically, the assumption of constant margins guarantees that forecast retail prices will increase at a lower rate than forecast refinery gate prices.)

The model adds projected cumulative increases in crude oil and nonproduct costs to an August 1978 base level price (for full service leaded regular gasoline) and adjusts the

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1/ DOE pricing rules establish maximum levels for retailer margins, though average margins (for leaded regular) have been estimated to be below this ceiling. In spite of the flexibility available in setting margins, the assumption of constant margins appears to be consistent with recent trends. Retailer margins for leaded regular gasoline at full service outlets averaged 8.4¢/gal. in 1975 and 8.3¢/gal. in 1977 (Lundberg Survey, Inc.). This does not indicate constant nominal profits for retailers, however, since over the same period the average sales volume per station increased, rising operating costs were mitigated by the trend toward self-service outlets, and sales shifted to the higher margin unleaded grades. These trends are expected to continue.

resulting projected price series for normal seasonal variations. These seasonal variations, on the order of three percent, result in higher prices in the peak demand summer driving months.

Current DOE pricing rules permit refiners to distribute total costs allocable to gasoline among the different grades of gasoline at their own discretion. Thus, while the STPCDM methodology is adequate to evaluate average price increases across all grades of gasoline, it does not account for disproportionate distribution of costs among grades. Additional assumptions which would be required to analyze, for example, any potential divergence in refiner's prices for leaded and unleaded grades have not been included in this study. Similarly, this study does not make any assumptions regarding any potential divergence in price margins for different grades at the retail level.

Price series presented in this analysis have not been developed as unique levels which will balance projected supply and demand. (Demand projections used here were based on the assumption of constant real prices, equivalent to Table 3, Case 3C.) Price projections from the STPCDM assume that supply will adjust to the projected demand. The absolute supply level then determines the requirement for imported crude oil, which consequently impacts on the refiners' average crude cost. The STPCDM methodology, however, is not sufficiently sensitive to demand changes to generate a unique equilibrium price. Accordingly, in the event gasoline prices are decontrolled, projections presented here should only be interpreted as measures of the cost pressures on product prices which would be present under the specific conditions outlined. With continued controls, price projections are only indicative of maximum allowable levels.

REFINER COSTS

Average price levels for refined petroleum products may be expected in the short-run to reflect increased costs incurred by domestic refiners. While this relationship is more direct for price-controlled products such as gasoline, price increases for other products will be higher or lower than any increase in refiner costs, depending on current market conditions. Table 2 summarizes the projected cumulative increase in refiners` crude oil and nonproduct costs over third quarter 1978 levels for both the low and high growth scenarios and for alternate assumptions regarding levels of increase in OPEC crude oil prices. Accordingly, these cost increases may be interpreted as weighted average petroleum product price increases expected as a result of the specific conditions outlined.

In general, nonproduct cost increases through 1980 should be consistent with recent historical experience in keeping pace with the general inflation rate. Composite crude oil costs (domestic and imported), however, will vary significantly depending primarily on the level of imported crude oil prices. Three crude oil price shedules evaluated in Table 2 for both low and high growth scenarios, respectively, are: Cases 2A and 2B, OPEC prices increasing 14.5 percent by the end of 1979 with no further increase in 1980; Cases 2C and 2D, OPEC price increasing 14.5 percent by the end of 1979, with a subsequent increase in 1980 to keep pace with U.S. inflation; and for comparison purposes, Case 2E and 2F, no OPEC increase in 1979 or 1980.

The 1979 OPEC price increase, which are expected to be followed by non-OPEC nations as well as producers of domestic uncontrolled oil, are scheduled for implementation over four quarters (respectively, 5 percent, 3.8 percent, 2.3 percent and 2.7 percent, compounding to 14.5 percent by the end of 1979). Since it is not clear at this time whether market conditions and the political environment will allow a further OPEC increase in 1980, this analysis considers Cases 2A and 2B (price increase of 14.5 percent in 1979 and 0.0 percent in 1980) as the most likely scenarios.

Comparing the announced OPEC increase case in 1979 to what would be expected with no OPEC increase indicates that OPEC price hikes will be responsible for an additional 2.7 to 2.8 cent per gallon in refiner costs by the end of 1979. In other words, by the end of 1979 over 50 percent of the 5.0 to 5.1 cents per gallon cumulative increase in total refiner costs will be attributable to the OPEC price hike. In 1980, if there is no further OPEC increase, total refiner cost will still be 6.8 to 7.4 cent per gallon higher than they were in third quarter 1978. However, a subsequent 1980 OPEC price increase at a level commensurate with U.S. inflation would add a further 1.4 to 1.6 cent per gallon to total refiner costs in that year.

MOTOR GASOLINE PRICES

Under current DOE rules all increases in refiner costs described in the preceding section could be added to gasoline prices. In addition to economic growth and world crude price conditions presented above, the actual level of gasoline prices will also depend on the exact proportion of refiner cost which are passed through. Table 3 compares the cumulative increase in retail gasoline prices which would be expected with both low and high economic growth if refiners (1) continued to pass through to prices gasoline's full volumetric share of total refiner cost increases (Case 3A), (2) passed through additional cost increases which would be allowable with the proposed gasoline tilt (Case 3B), or (3) increased retail prices to keep pace with the rate of inflation, as measured by the projected CPI (Case 3C). Currently, refiners may only increase gasoline prices by gasoline's pro rata volumetric share of total cost increases (Case 3A). (Thus, Case 3A price increases are based directly on the total refiner cost increases in Table 2, Cases 2A and 2B, adjusted for seasonal gasoline price variations.) The Economic Regulatory Administration (ERA), however, has considered a proposal which, if adopted, would allow refiners to pass through 110 percent of gasoline's volumetric share of crude oil costs and approximately 150 percent of gasoline's volumetric share of total nonproduct costs (Table 3, Case3 B).[3/] This is the so-called "gasoline tilt" ruling, and is designed to enable refiners to recoup additional costs usually associated by refiners with gasoline production. If the tilt ruling had been implemented in December 1978 as originally proposed, refiners would have been able to pass through 5.8 to 6.2 cents per gallon to gasoline prices by the end of 1980 in addition to what would be possible under current DOE pricing rules (Table 3, Case3B minus Case 3A). A later implementation date for the tilt ruling would postpone the price impact of the tilt presented in Table 3.

By 1980 in the low growth scenario, straight (pro rata) volumetric passthrough of allowable cost increases, per current pricing rules, could limit gasoline prices to 3.5 cents per gallon below the increases expected if prices continued to escalate with inflation (Table 3, Case 3C minus Case 3A).

3/ A second proposed ruling by the ERA would allow gasoline retailers to pass through to prices rent increases and costs associated with the mandatory purchase of vapor recovery systems. The impact of this ruling has not been included in retail margins in this analysis because (1) there are no reliable estimates of the costs involved and (2) unless all retailers in the same market are faced with these costs, it is not likely that market conditions would permit their recoupment in higher prices.

In the high growth scenario, maximum allowable prices with straight volumetric cost passthrough would still be 1.7 cents per gallon lower in 1980 than in the general inflation case, reflecting the lower inflation expected in the high growth scenario. In spite of refiner costs increasing at or above the general inflation rate through 1980, retail gasoline prices will decline in real terms primarily because of the regulatory and market constraints on distributor margins (see footnote, page six), but also because of restrictions on refiner cost passthroughs.

MOTOR GASOLINE BANKS

Refiners` banks of unrecouped costs of producing gasoline are defined as the cumulative increase in refiners` costs allocable to gasoline prices since May 1973 less the cumulative increase in recoupments (i.e., sales revenues) since May 1973. Under current DOE pricing rules, refiners are constrained in setting gasoline prices by both their current cost increases (lagged one month) and the sum of past cost increases which have not yet been recouped (i.e., gasoline banks). Costs allocable to gasoline may include, at the refiners discretion, both current costs (lagged one month) and unrecouped costs (banks) associated with other price-controlled products. There are no restrictions on the pass-through of current cost increases (incurred within the past two months). For unrecouped costs (incurred more than two months past), however, only 10 percent of the highest level of unrecouped costs banked in the past may be passed through to prices in any one month. The relationship between banks and ceiling prices is described in Figure 1.

Motor gasoline banks (for 30 large refiners as reported in the EIA Monthly Energy Review) are projected in Table 4. Projections extend only through 1979, reflecting the greater uncertainty inherent in the banks sub-model of the STPCDM.

All projections assume monthly reallocations of costs associated with other products to motor gasoline prices remain constant at the August 1978 level. Trends in markets for other price-controlled products and the outcome of possible DOE proposals to decontrol these other products will impact significantly on the actual level of reallocations.

Projections of banks under two economic growth scenarios and four alternate assumptions on the level of cost pass-through are considered. These cases encompass a large range of potential bank levels. All projections indicate levels lower than may otherwise be expected due primarily to the fact that projections are initiated from the low August 1978 level ($442 million), which reflected the record high gasoline consumption and stock drawdown during summer 1978. (Sales from gasoline stocks constitute recoupments for which there is no offsetting current cost, so that prices can only be maintained or increased by allocating costs from banks.) If gasoline stocks were built up this winter to normal levels, the additional unrecouped costs accumulated would restore banks to levels higher than indicated in Table 4.

This analysis indicates that the lowest level of motor gasoline banks which could be expected in 1979 is associated with the combination of continued current pro rata volumetric cost allocation rules and retail prices increasing with the general rate of inflation (Table 4, Case 4C). In this scenario the assumption of constant nominal retail margins results in refinery level prices increasing faster than the general inflation rate. To support this accelerated price increase, refiners must draw down banks. In the high growth (low inflation) scenario of Case 4C, banks are maintained at low levels, comparable to those attained in fall 1978. In the low growth (high inflation) case, however, banks are drawn down to $100 million, an unprecedented low. Pressure on bank levels would be reduced by either price increases in line with allowable current cost increases (Case 4A) or implementation of a gasoline tilt (Cases 4B and 4D).

Expected 1979 bank levels would have no significance for 1980 gasoline prices if gasoline prices were decontrolled before that time. However, if gasoline remains a controlled product and a tight gasoline supply/demand balance develops, the level of banks could significantly constrain or facilitate refiners` efforts to raise prices in response to a tight supply situation.

In order to indicate the pricing flexibility (i.e., the ability of refiners to increase gasoline prices at a higher rate than their current cost increases) afforded to refiners by different levels of banks, Table 4 also presents projections of the potential additional price increase which could be sustained for one quarter if all gasoline banks were completely passed through to prices in that quarter. The one-quarter price impact is estimated as average banks for each quarter divided by total gasoline production for that quarter. (This price increase would be in addition to the increases projected in Table 3 since, given the 10 percent one-month passthrough limitation noted above, this total increase may be in excess of that allowed by DOE pricing rules. There would be no cumulative effect of the price impacts indicated in Table 4.) An increase or decrease in reallocations of costs from other products would increase or decrease, respectively, the estimate of maximum one-quarter price increases made possible by allocating all gasoline banks.

The degree of pricing flexibility afforded by a certain level of gasoline banks will vary depending both on the levels of gasoline production and sales, and on the levels of refiners' allocable costs and prices. With declining bank levels and increasing production, all cases considered in this analysis, except Case 4D, indicate decreased refiner pricing flexibility. Case 4D, which assumes retail prices increase with inflation and refiners are allowed to allocate additional costs associated with the gasoline tilt, indicates increased pricing flexibility in 1979 relative to 1977 for the high growth (low inflation) scenario. Refiners' pricing flexibility appears most constrained relative to 1977 in Case 4C, which assumes both the continuation of current pro rata volumetric passthrough pricing rules and retail prices increasing with inflation. In Case 4C, with low economic growth and high inflation, refiners come closest to the point of being legally constrained in their pricing behavior.

Of course, if refiners were to increase prices to market clearing levels, the extra flexibility afforded by bank drawdowns may not be needed. However, if banks are already at low levels before the summer driving season or before some unexpected surge in demand or restriction on production that forces reliance on stock drawdowns, refiners could quickly become constrained by low bank levels. The development of a tight supply situation in 1980 in conjunction with the bank levels presented in Case 4C indicates that price increase may not be available to refiners as a strategy for dealing with excess demand.

Industry pricing behavior need not be constrained, however, even when gasoline banks are exhausted. Since firms can freely reallocate from other product banks to gasoline prices, firms would only be <u>legally</u> constrained when banks for all controlled products reach zero. The lowest level of total banks which would <u>effectively</u> constrain prices, however, is also not zero.

If individual firms accounting for a significant market share are out of total banks and thus legally constrained, their competitors who still have banks may not be willing to raise prices at the risk of losing market position. In August 1978 firms accounting for approximately 20 percent of total gasoline sales by the 30 largest refiners were out of total banks. Since these firms do not compete in all markets served by the remaining large refiners, it is not likely that August prices were constrained. However, this study has not included the detailed market analysis which would be required to determine the degree of competition between individual firms. In August 1978 there was no difference in average prices (leaded regular dealer tank wagon) between firms without total banks and their major competitors.

MOTOR GASOLINE INVENTORIES

As noted in the previous section, a refiner's inventory strategy can have a significant impact on bank levels and consequently on pricing flexibility. Projected levels of motor gasoline stocks consistent with projections of refiners' costs and gasoline banks described in this analysis are presented in Table 5. These projections assume that average annual gasoline production will be at a level which, when added to gasoline imports, will balance projected average annual demand. The methodology, which assumes normal seasonal variation in production rates, imports and demand, estimates quarterly changes in stocks as quarterly demand less supply (production plus imports). Projected cumulative changes in stocks are added to August 1978 actual stocks to derive estimates of future levels.

Since August 1978 stocks were at exceptionally low levels, projected stocks presented in Table 5 are at lower levels than may actually be experienced. If refiners increase gasoline production in 1979 above levels required to balance demand in order to build up stocks to normal levels (34 days supply, the average level for 1976-78)by the end of 1979, gasoline supply would have to be increased about .5 percent in the low growth case and about 1.5 percent in the high growth case above the levels assumed here.[4/] At the time this report was prepared, however, the late 1978 stock situation was exacerbated by continued above-normal demand, indicating there may be limited opportunity for refiners to rebuild stocks this winter to historical levels. This analysis indicates 1979 and 1980 gasoline stock levels comparable to 1978 in the low growth (low gasoline demand) scenario and lower than 1978 in the high growth (high demand) scenario. In both scenarios stocks should be adequate to maintain normal market operations.

If refiners were to increase production for stock buildup, they would incur costs which could not be immediately recouped. Hence, gasoline banks would increase. If these additional stocks were subsequently marketed in 1980, in response to a developing tight supply, 1980 gasoline banks would return to the level anticipated if there had been no 1979 buildup.

4/ Under current DOE pricing rules, refiners may recoup only the explicit costs of producing and storing inventories. Since (1) these inventories constitute an investment of resources and (2) DOE rules do not allow any return on this investment to be passed through to product prices, refiners have little incentive to carry inventories at levels higher than required to maintain normal market operations.

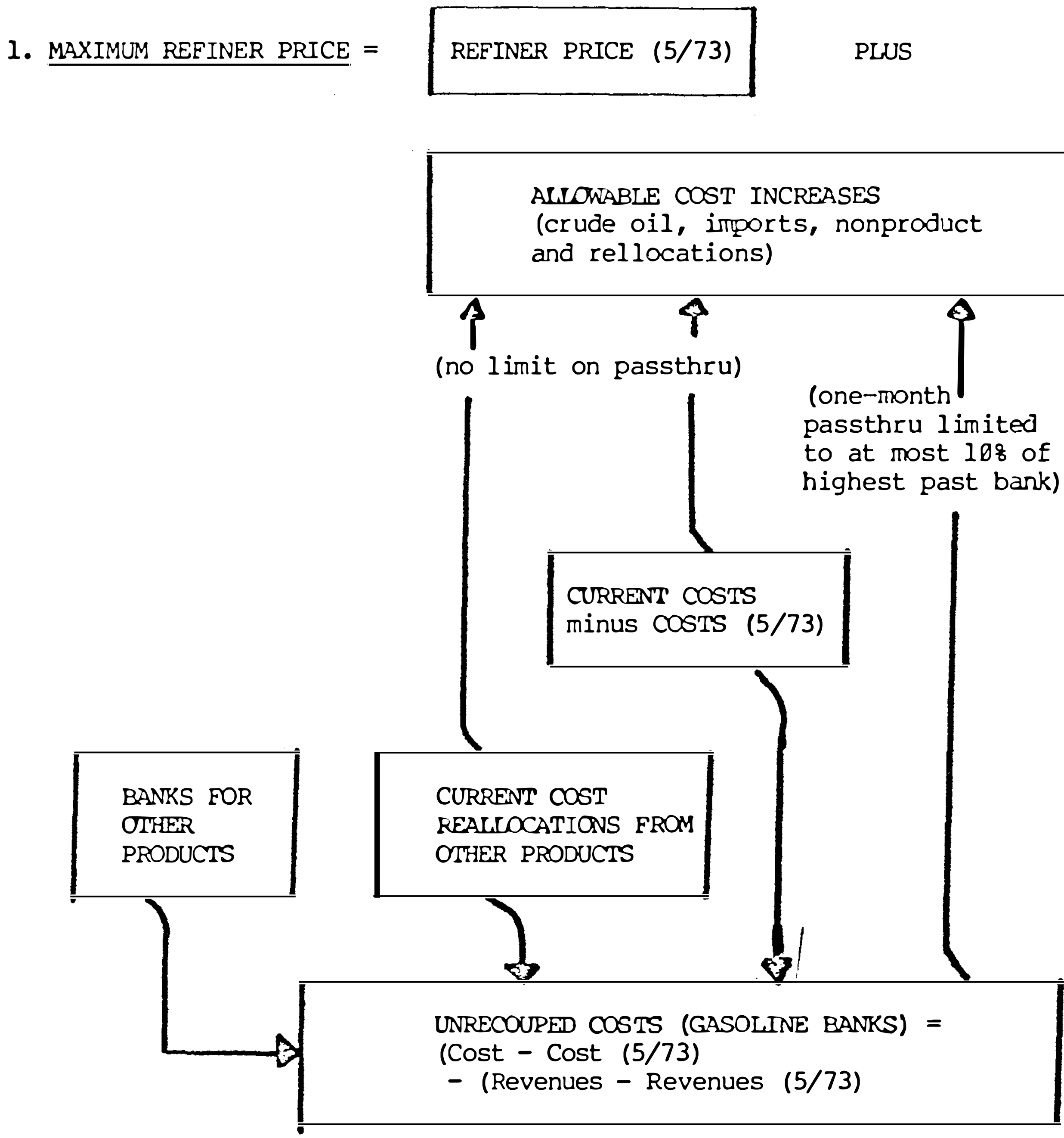
CONCLUSIONS

Even under price controls the range of potential prices which may be established through 1980 is significant. Maximum allowable prices will vary significantly with economic growth (which will determine gasoline demand, the volume of high cost imported crude oil required to satisfy demand, and consequently the average crude oil cost) and the inflation rate (which will affect all production costs). Refiners, however, need not set prices at maximum levels. The proportion of allowable costs actually passed through to gasoline prices may be increased as a result of the recently proposed "gasoline tilt" ruling, allowing further variation in potential price levels. Retail gasoline prices could increase through 1980 between 6.6 and 7.2 cents per gallon with continuation of current pricing rules and between 12.4 and 13.4 cents per gallon with the gasoline tilt ruling. Price increases necessary to keep pace with inflation over the same period would be between 8.3 and 10.7 cents per gallon.

An important consideration besides the actual price level is the additional flexibility refiners would have to increase prices further in response to short-term market fluctuations. This analysis indicates that pricing flexibility becomes increasingly constrained as an increasing proportion of allowable costs are passed through to prices. With the assumptions of constant retailer margins and retail prices increasing with the general inflation rate, pricing flexibility would be more constrained in the low growth (high inflation) economic scenario than in the high growth (low inflation) case.

FIGURE 1

OVERVIEW OF DOE GASOLINE PRICING RULES



2. MAXIMUM RETAIL PRICE = CURRENT REFINER PRICE

\+ CEILING RETAIL MARGIN

TABLE 1

MACROECONOMIC ASSUMPTIONS AND MOTOR GASOLINE DEMAND PROJECTIONS

1A. Low Growth Case

	1977	1978 b/	1979	1980
Inflation Rates (%) a/				
GNP Deflator	5.5	6.9	7.0	7.4
CPI	6.5	6.9	7.1	7.2
Gasoline Demand (bbl/d) - high conservation	7,176	7,400	7,400	7,600

1B. High Growth Case

	1977	1978 b/	1979	1980
Inflation Rates (%) a/				
GNP Deflator	5.5	6.2	5.6	6.0
CPI	6.5	6.2	5.7	5.7
Gasoline Demand (bbl/d) - low conservation	7,176	7,400	7,800	8,000

a/ Measured from mid-year to mid-year.

b/ Preliminary actual.

Source: EIA Analysis Memorandum "1980 Motor Gasoline Supply and Demand" (AM/ES/79-12).

TABLE 2

PROJECTED CUMULATIVE CRUDE OIL AND NONPRODUCT COST INCREASES WITH CONTINUED CONTROLS a/
(cents per gallon)

Year and Quarter	Composite Crude Oil Cost Increase	Refiner Nonproduct Cost Increase	Total Increase
	2A. Low Growth/Full OPEC Increase in 1979, No OPEC Increase in 1980 b/		
1978			
4th	.2	.2	.4
1979			
1st	1.0	.5	1.5
2nd	2.3	.7	3.0
3rd	3.0	1.0	4.0
4th	3.8	1.3	5.1
1980			
1st	3.9	1.5	5.4
2nd	4.5	1.8	6.3
3rd	4.7	2.1	6.8
4th	5.0	2.4	7.4
	2B. High Growth/Full OPEC Increase in 1979, No OPEC Increase in 1980 b/		
1978			
4th	.1	.2	.3
1979			
1st	1.3	.4	1.7
2nd	2.5	.6	3.1
3rd	3.1	.8	3.9
4th	4.0	1.0	5.0
1980			
1st	4.0	1.3	5.3
2nd	4.5	1.5	6.0
3rd	4.7	1.7	6.4
4th	4.9	1.9	6.8

a/ Cummulative increase over 3rd quarter 1978, assuming continuation of DOE crude oil pricing rules.

b/ Compound increase in OPEC price in 1979 is 14.5 percent. There is no OPEC increase in 1980.

TABLE 2 (cont'd)

PROJECTED CUMULATIVE CRUDE OIL AND NONPRODUCT COST INCREASES WITH CONTINUED CONTROLS a/
(cents per gallon)

Year and Quarter	Composite Crude Oil Cost Increase	Refiner Nonproduct Cost Increase	Total Increase
	2C. Low Growth/Full OPEC Increase in 1979, OPEC Increase in 1980 with Inflation		
1978			
4th	.2	.2	.4
1979			
1st	1.0	.5	1.5
2nd	2.3	.7	3.0
3rd	3.0	1.0	4.0
4th	3.8	1.3	5.1
1980			
1st	5.4	1.5	6.9
2nd	6.1	1.8	7.9
3rd	6.3	2.1	8.4
4th	6.6	2.4	9.0
	2D. High Growth/Full OPEC Increase in 1979 c/, OPEC Increase in 1980 with Inflation		
1978			
4th	.1	.2	.3
1979			
1st	1.3	.4	1.7
2nd	2.5	.6	3.1
3rd	3.1	.8	3.9
4th	4.0	1.0	5.0
1980			
1st	5.4	1.3	6.7
2nd	5.9	1.5	7.4
3rd	6.1	1.7	7.8
4th	6.3	1.9	8.2

a/ Cumulative increase over 3rd quarter 1978, assuming continuation of DOE crude oil pricing rules.

c/ Compound increase in OPEC price in 1979 is 14.5 percent. Respective increases in imported crude oil costs in January 1980 of 7.0 percent in Case 2C and 5.6 percent in Case 2D.

TABLE 2 (cont'd)

PROJECTED CUMULATIVE CRUDE OIL AND NONPRODUCT COST INCREASES WITH CONTINUED CONTROLS a/
(cents per gallon)

Year and Quarter	Composite Crude Oil Cost Increase	Refiner Nonproduct Cost Increase	Total Increase
	2E. Low Growth/No OPEC Increase in 1979 or 1980		
1978			
4th	.2	.2	.4
1979			
1st	.1	.5	.6
2nd	.7	.7	1.4
3rd	.8	1.0	1.8
4th	1.1	1.3	2.4
1980			
1st	1.3	1.5	2.8
2nd	1.7	1.8	3.5
3rd	2.0	2.1	4.1
4th	2.3	2.4	4.7
	2F. High Growth/No OPEC Increase in 1979 or 1980		
1978			
4th	.1	.2	.3
1979			
1st	.3	.4	.7
2nd	.8	.6	1.4
3rd	.9	.8	1.7
4th	1.2	1.0	2.2
1980			
1st	1.3	1.3	2.6
2nd	1.7	1.5	3.2
3rd	1.8	1.7	3.5
4th	2.0	1.9	3.9

a/ Cummulative increase over 3rd quarter 1978, assuming continuation of DOE crude oil pricing rules.

Source: EIA Short-Term Petroleum Cost Distribution Model (11-3-78).

TABLE 3

PROJECTED ALLOWABLE CUMULATIVE RETAIL GASOLINE PRICE INCREASES WITH CONTINUED CONTROLS a/

Year and Quarter	Low Growth Case	High Growth Case
3A. Assuming Full Volumetric Passthrough of Increased Costs, as Allowed by Current DOE Rules		
1978		
4th	.2	.1
1979		
1st	.7	.8
2nd	2.8	2.8
3rd	4.2	4.2
4th	4.7	4.6
1980		
1st	5.1	4.9
2nd	6.4	6.1
3rd	7.2	6.8
4th	7.2	6.6
3B. Assuming Greater than Volumetric Passthrough of Increased Refiner Costs, as Allowed by Proposed Gasoline Tilt b/		
1978		
4th	.2	.1
1979		
1st	5.3	5.3
2nd	7.6	7.6
3rd	9.2	9.0
4th	10.0	9.8
1980		
1st	10.6	10.2
2nd	12.1	11.6
3rd	13.1	12.3
4th	13.4	12.4

TABLE 3 (cont'd)

PROJECTED ALLOWABLE CUMULATIVE RETAIL GASOLINE PRICE INCREASES WITH CONTINUED CONTROLS a/
(cents per gallon)

Year and Quarter	Low Growth Case	High Growth Case
3C. Assuming Prices Increase with CPI		
1978		
4th	.9	.6
1979		
1st	1.7	1.2
2nd	3.5	2.8
3rd	4.8	4.0
4th	5.7	4.7
1980		
1st	6.6	5.3
2nd	8.5	6.9
3rd	9.8	7.9
4th	10.7	8.3

a/ Cumulative increase in full service leaded regular gasoline prices over 3rd quarter 1978. Case 3A and 3B assume refiner cost increases as presented in Case 2A and 2B, resp., of Table 2 and constant retailer margins. Case 3C assumes retail prices increase at same rate as Consumer Price Index, adjusted for normal seasonal variation.

b/ In this analysis the gasoline tilt was assumed to be effective in December 1978.

Source: EIA Short-Term Petroleum Cost Distribution Model (11-3-78)

TABLE 4

PROJECTED UNRECOUPED COSTS FOR GASOLINE AND POTENTIAL ONE-QUARTER PRICE INCREASE (30 Large Refiners) a/

Year and Quarter	Low Growth Case		High Growth Case	
	Bank (MM$)	Price Impact (¢/gal.)	Bank (MM$)	Price Impact (¢/gal.)
1977				
1st	965	3.7		
2nd	984	3.7		
3rd	806	2.9		
4th	867	3.2	same	
1978				
1st	1,128	4.4		
2nd	860	3.2		
4A. Assuming Full Volumetric Passthrough of Increased Costs, as Allowed by Current DOE Rules				
1978				
3rd	600	2.1	600	2.0
4th	750	2.6	700	2.4
1979				
1st	800	2.9	750	2.8
2nd	550	1.9	500	1.7
3rd	600	2.1	600	1.9
4th	600	2.1	500	1.9
4B. Assuming Greater than Volumetric Passthrough of Increased Refiner Costs, as Allowed by Proposed Gasoline Tilt b/				
1978				
3rd	600	2.1	600	2.0
4th	750	2.6	700	2.4
1979				
1st	750	2.8	700	2.6
2nd	450	1.7	450	1.5
3rd	550	1.9	500	1.7
4th	500	1.9	500	1.7

TABLE 4 (cont'd)

PROJECTED UNRECOUPED COSTS FOR GASOLINE AND POTENTIAL ONE-QUARTER PRICE INCREASE (30 Large Refiner) a/

Year and Quarter	Low Growth Case		High Growth Case	
	Bank (MM$)	Price Impact (¢/gal.)	Bank (MM$)	Price Impact (¢/gal.)
4C. Assuming Passthrough of Increased Cost Allowed by Current DOE Rules. Retail Prices Increase with CPI. c/				
1978				
3rd	600	2.1	600	2.0
4th	700	2.4	650	2.3
1979				
1st	650	2.5	750	2.8
2nd	250	.8	500	1.8
3rd	150	.6	600	2.0
4th	100	.3	550	1.9
4D. Assuming Passthrough of Increased Costs Allowed by Gasoline Tilt. Retail Prices Increase with CPI. b/c/				
1978				
3rd	600	2.1	600	2.0
4th	700	2.4	650	2.3
1979				
1st	1,000	3.9	1,100	4.1
2nd	650	2.3	950	3.2
3rd	600	2.1	1,050	3.5
4th	500	1.9	1,000	3.5

a/ One-quarter price increase is defined as average quarterly banks divided by total quarterly production. These increases are not cumulative. Assumes refiner cost increase as presented in Case 2A and 2B of Table 2.

b/ In this analysis the gasoline tilt was assumed to be effective in December 1978.

c/ The combined assumptions of retail prices increasing with the CPI (Table 3, Case 3C) and constant retail margins result in refiner prices in this case increasing faster than the CPI.

Source: EIA Short-Term Petroleum Cost Distribution Model (11-3-78)

TABLE 5

ANALYSIS OF IMPACT OF SUPPLY/DEMAND BALANCE
ON MOTOR GASOLINE STOCKS a/
(3 month average)

5A. Low Growth Case

Year/Qtr.	Domestic Demand (thousands	Production b/ of barrels per	Imports day)	Stocks (thousand barrels)	Days Supply
1978 1st	6937	6771	187	267,722	39
2nd	7618	6980	196	234,117	31
3rd	7650	7350	200	212,000	28
4th	7300	7250	175	220,000	30
1979 1st	6850	6900	200	246,000	36
2nd	7700	7300	250	239,000	31
3rd	7800	7550	200	238,000	31
4th	7450	7200	175	229,000	31
1980 1st	6950	6900	300	246,000	35
2nd	7850	7300	350	238,000	30
3rd	7950	7600	300	236,000	30
4th	7600	7250	275	229,000	30

5B. High Growth Case

Year/Qtr.	Domestic Demand	Production	Imports	Stocks	Days Supply
1978 3rd	7720	7380	200	211,000	27
4th	7550	7350	175	206,000	27
1979 1st	7150	7250	200	227,000	32
2nd	8000	7650	250	220,000	27
3rd	8100	7900	200	219,000	27
4th	7800	7500	175	210,000	27
1980 1st	7300	7350	300	233,000	32
2nd	8200	7800	350	232,000	28
3rd	8300	8100	300	240,000	29
4th	8000	7700	275	242,000	30

a/ Neither the low or high growth scenario assumes any additional increase in gasoline production to rebuild gasoline stocks after the high drawdown in summer 1978. An increased supply of gasoline of between .5 and 1.5 percent in 1979 would be necessary to bring stocks up to their 1977 relative level.

b/ Production required to balance demand. This is not a projection based on refiner capabilities or intentions.

Source: EIA Short-Term Petroleum Cost Distribution Model (11-3-78).

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GLOSSARY

1) Banked (Unrecovered) Costs - Allowable costs which a refiner has been unable to recover because of market competition. These costs may be recovered over an extended time frame by an increase in the allowable price margin.

2) Dealer Margin - Margin is the gross difference between delivered purchase price and retail price at the pump. Dealers allowable margin is their margin existing on September 15, 1973, plus 3 cents. Under the Gasoline Tilt regulation, if adopted, dealers would also be allowed to recover increased rent costs, plus cost of installing vapor recovery systems.

3) Dealer Tank Wagon (DTW) Price - The price at which a dealer purchases gasoline from a distributor or jobber.

4) Detuning - Reducing engine performance by spark retardation in order to reduce knocking.

5) Dieseling - Continued operation of an engine after ignition switch is turned off. Effect can be mitigated by increase in octane number of gasoline or detuning.

6) Entitlements - A regulatory method used by the ERA to equalize the cost of crude oil to U.S. refiners. The price of an entitlement, fixed by ERA, is the exact differential as reported for the month between the weighted average delivered cost per barrel to refiners of both imported crude oil and stripper crude oil, and the weighted average delivered cost to refiners of "old oil" less 21 cents.

7)	Fuel Switching -	Misfueling, i.e., use of leaded gasoline in cars required by law to use unleaded gasoline.
8)	Gasoline, Fighting Grade -	Gasoline sold at reduced margins to attract customers and/or meet local competitive prices. Has usually been regular grade, leader gasoline.
9)	Gasoline, Regular Grade -	Gasoline blended to meet performance requirements of most vehicles.
10)	Gasoline, Premium Grade -	Gasoline blended to meet performance requirements of pre-1975 and other vehicles with high compression engines, which will not perform satisfactorily on regular grade gasoline.
11)	Gasoline, Leaded -	Gasoline containing more than 0.05 grams of lead per gallon.
12)	Gasoline, Unleaded -	Gasoline containing 0.05 grams of lead per gallon or less.
13)	Gasoline Additives -	For many years, organic lead compounds have been added to gasoline to improve engine performance. More recently, MMT (a manganese compound) has been added to unleaded gasoline to improve its performance. The use of MMT is now prohibited in all gasoline. The use of lead compounds is proscribed in unleaded gasoline, and quantities available to refiners for upgrading leaded gasoline will be reduced to 0.5 grams of lead per gallon will be reduced to 0.5 grams of lead per gallon for their total gasoline pool effective October 1, 1979. Other potential additives are either (1) not approved, (2) not available in sufficient quantities, or (3) not cost effective at present price levels for gasoline.

14)	Gasoline Pool -	Total quantity of gasoline produced.
15)	Gasoline Tilt -	Historically, gasoline prices reflected more than their volumetric proportion of petroleum product costs because of the additional processing required to manufacture gasoline. Gasoline tilt would recognize this added cost by permitting the "pass through" of these costs on allowable gasoline prices.
16)	Knocking -	Phenomenom created by preignition of gasoline in combustion chambers. Mild knocking (low noise level) is not harmful to the engine. Severe knocking may damage pistons and cylinder heads. Knocking can be mitigated by increase in octane number of gasoline or by engine detuning, which would lower performance.
17)	Margin -	See "Dealer Margin"
18)	Misfueling -	See "Fuel Switching"
19)	Octane -	Refers to octane number
20)	Octane Number -	A measurement of anti-knock quality of gasoline. Two test measures are used - Research Octane Number (RON) and Motor Octane Number (MON). The average of these two numbers (RON + MON divided by 2) is used as an approximation of anticipated road performance. The EPA regulation specifies a minimum RON of 91 for unleaded gasoline.
21)	Octane Rating -	Octane number measurements. May refer to RON, MON or RON + MON/2.
22)	Clear Pool Octane -	Octane number of gasoline pool, prior to addition of lead compounds or other additives.
23)	Price Spread, or - Differential	The difference in selling prices between grades of gasoline.

24) Rack Price - Price at refinery.

25) Retail Outlets: Type of Services:

26) Full Serve - Motor vehicle services are provided by an attendent, such as pumping gas, washing windows, checking under the hood, checking tire pressure, etc.

27) Self Serve - Motor vehicle services are not provided by attendants.

28) Split-Island - Both full-serve and self-serve facilities are provided.

LIST OF ABBREVIATIONS

A	API	American Petroleum Institute
B	bbl	Barrel(s)
	B/D	Barrels per day
	Btu	British thermal units
	B/yr	Barrels per year
C	CFR	Code of Federal Regulations
	CO	Carbon monoxide
	CONTROL 0727	A forecast of the economy of the U.S. developed by Data Resources, Inc.
	CVS	Constant Volume Samples
D	DEIS	Draft Environmental Impact Statement
	DOE	Department of Energy
	DOT	Department of Transportation
	DRI	Data Resources, Inc.
E	EIA	Energy Information Administration
	EIS	Environmental Impact Statement
	EPA	Environmental Protection Agency
	EPAA	Emergency Petroleum Allocation Act
	EPCA	Energy Policy and Conservation Act
	ERA	Economic Regulatory Administration
	ESCON	A computer program developed by Du Pont
F	FEA	Federal Energy Administration
	FERC	Federal Energy Regulatory Commission
	FMVCP	Federal Motor Vehicle Control Plan
	FR	Federal Register
	FSR	Fuel switching rate
	FTC	Federal Trade Commission
	FTP	Federal Test Procedure
G	g/bhp-hr	Grams per brake horsepower-hour
	g/km	Grams per kilometer
	g/mi	Grams per mile
	GM; GMC	General Motors Corporation
	GNP	Gross national product
H	HC	Hydrocarbon(s)
I	I/M	Inspection/maintenance
K	kg	Kilogram(s)
L	lb	Pound(s)

M	MB/D	Thousand barrels per day
	MB/SD	Thousand barrels per stream day
	MMB/D	Million (thousand thousand) barrels per day
	MMT	Methylcyclopentadienyl manganese tricarbonyl
	MMTm	Million (thousand thousand) metric tons
	MMTm/yr	Million (thousand thousand) metric tons per year
	MON	Motor Octane Number
	mph	Miles per hour
	MVMA	Motor Vehicle Manufacturers Association
N	NAAQS	National Ambient Air Quality Standards
	NEP	National Energy Plan
	NIPA	National Income and Product Accounts
	NGL	Natural Gas Liquids
	NOx	Nitrogen Oxides
	NPN	National Petroleum News
p	PAD	Petroleum Administration for Defense
	Pb	Lead
	P.L.	Public Law
	ppm	Parts per million
R	ROI	Return on Investment
	RON	Research Octane Number
S	SAFS	State and Area Forecasting System (Data Resources, Inc.)
	SEA	Selective Enforcement Audit
	SIP	State Implementation Plan(s)
	SO_x	Sulfur oxides
	STPDFM	Short-Term Petroleum Demand Forecasting Model
V	VMT	Vehicle Miles Traveled