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Report to the Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce, House of Representatives

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AIR POLLUTION

EPA's Efforts to Control Vehicle Refueling and Evaporative Emissions

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Resources, Community, and
Economic Development Division

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August 7, 1987

The Honorable John D. Dingell
Chairman, Subcommittee on
Oversight and Investigations
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

As you requested, this report discusses the Environmental Protection Agency's (EPA's) efforts to control gasoline vapors emitted during vehicle refueling and through evaporation of gasoline stored in the vehicle fuel system. The report provides information on EPA's estimates of the costs and benefits of different alternatives for controlling refueling and evaporative emissions and the status of EPA's proposed control strategies for these emissions.

Unless you publicly release its contents earlier, we will not make this report available to other interested parties until 30 days after the date of this letter. At that time copies of the report will be sent to appropriate congressional committees; the Administrator, EPA; and the Director, Office of Management and Budget. We will also make copies available to others upon request.

This work was performed under the general direction of Hugh J. Wessinger, Senior Associate Director. Major contributors are listed in appendix III.

Sincerely yours,

J. Dexter Peach

J. Dexter Peach
Assistant Comptroller General

Executive Summary

Purpose

Nearly 77 million people live in areas throughout the country that exceed the federal health standard for ozone established under the Clean Air Act. Scientific research links ozone to a number of health problems, including reduced lung functions and resistance to infection. Gasoline vapors emitted from motor vehicles contribute significantly to ozone formation.

Concerned with the number of areas that have not attained the federal ozone standard, the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, requested that GAO examine

- the status of the Environmental Protection Agency's (EPA's) efforts to control gasoline vapors from motor vehicles, including emissions that occur (1) during refueling and (2) as gasoline evaporates from the fuel tank, carburetor, or fuel-injection system (evaporative emissions); and
- EPA's analyses of the costs and benefits of alternative policy actions.

Background

Ozone, often called smog, is formed when hydrocarbons and nitrogen oxides, released by motor vehicles and various other sources, react in the presence of sunlight. EPA's strategy to reduce ozone emphasizes controlling hydrocarbon emissions, about one-half of which come from motor vehicles.

Since 1973, EPA has been analyzing ways to control refueling emissions and is considering two alternatives. One, known as stage II controls, would require gasoline station owners and operators to install vapor recovery equipment on their fuel pumps. The other, known as onboard controls, would require motor vehicle manufacturers to equip vehicles with emission control systems.

In 1983, EPA began analyzing ways to control excess evaporative emissions. One method would require oil companies to lower the volatility of the commercial gasoline consumers use in their vehicles. The other would equate the volatilities of the gasoline used to certify evaporative emission systems and commercial gasoline, and require modification of vehicle emission controls as appropriate.

In March 1987, EPA submitted to the Office of Management and Budget (OMB) draft proposals to regulate refueling and evaporative emissions that would require (1) the installation of onboard controls to reduce refueling emissions and (2) the reduction of commercial gasoline volatility to control evaporative emissions. The EPA Administrator announced on July 22, 1987, that these proposals would soon be published in the Federal Register for public comment.

Results in Brief

EPA's draft proposals attempt to balance competing concerns—the costs of the control options, their implementation time, and their emission reduction benefits. With respect to refueling alternatives, EPA concluded that onboard controls are the best approach because they (1) provide greater long-term emission reductions than stage II controls, (2) are at least as cost-effective, and (3) are easier to implement. This alternative is opposed primarily by the automobile industry, which cites the added cost of the onboard controls.

Regarding evaporative emissions, EPA favors commercial gasoline volatility controls, which could achieve emission reductions more quickly than modifying vehicle control systems. This strategy would affect the oil industry most directly because it would increase refining costs. The automobile industry would be largely unaffected by this option.

EPA's draft analyses of the refueling and evaporative emission control strategies provide useful information on the costs and benefits of regulating these sources of emissions. However, GAO's critique of EPA's analyses identified several issues that, if addressed, would help clarify EPA's analyses and provide valuable information to assist the Congress and others in evaluating current and future regulatory strategies for achieving the ozone standard. Most of the information EPA would need to address these issues is currently available. Therefore, the agency could deal with them in its final analyses without, in GAO's opinion, delaying the rulemaking process.

Principal Findings

EPA's Plans to Control Refueling Emissions

EPA's March 1987 draft proposal provides the latest estimates of the costs and benefits of onboard and stage II controls for reducing refueling emissions. It shows that nationwide stage II controls would cost from $170 million to $190 million a year and would raise the retail price of gasoline by less than one cent per gallon, while nationwide onboard controls would cost $180 million a year and would add $19 to the purchase price of the average vehicle. EPA estimates that refueling controls would reduce nationwide emissions by about 2 percent.

In its draft proposal, EPA recommends that onboard controls be implemented in new vehicles, beginning with the 1990 model year, to control refueling emissions. Although EPA does not propose a strategy that also federally mandates stage II controls, it recognizes that some areas with severe ozone problems may be required to implement such controls as interim measures for controlling refueling emissions while waiting for onboard controls to take effect.

In deciding to propose onboard controls, EPA had to consider the relative importance and tradeoffs associated with a variety of factors such as costs, emission reductions, and ease of enforcement. EPA states that onboard controls offer significant advantages over stage II controls because they will provide greater long-term emission reductions at similar or less cost, automatically cover all areas, and avoid consumer involvement in the operation of the control equipment. Differences continue to exist, however, between EPA, the motor vehicle manufacturers, and others concerning onboard and stage II control costs, implementation time, and safety. (See ch. 2.)

EPA's Plans to Control Evaporative Emissions

In its March 1987 draft proposal, EPA recommends that a control strategy be implemented to reduce the volatility of commercial gasoline during the summer months (the period of peak ozone problems), beginning in 1989, to a level closer to that of the gasoline used to certify the evaporative emission systems. EPA expects its proposed strategy to reduce hydrocarbon emissions nationwide by 6 percent in 1989 and 9 percent in 1992. Further, EPA estimates that it will cost oil refineries $490 million annually, with a net cost to consumers of about $200 million, or under $20 per vehicle during the vehicle's life.

Similar to the refueling decision, EPA's proposal to reduce commercial gasoline volatility involved complex tradeoffs, with timeliness and emission reductions being key factors. The agency notes that its proposal has the advantage of achieving emissions control immediately upon implementation, whereas vehicle-based controls (i.e., evaporative canister modifications) would take years to begin having a real effect.

Differences exist between the motor vehicle and oil industries as to how best to control excess evaporative emissions. The motor vehicle industry favors lowering the volatility of commercial gasoline and opposes modifications to the vehicle evaporative emission control system. The oil industry, on the other hand, favors raising the volatility of certification gasoline to or near the current level of commercial gasoline and modifying the evaporative emission control systems to handle the higher volatility gasoline. (See ch.3.)

Additional Information Would Improve Usefulness of EPA's Analyses

EPA uses a standard, or benchmark figure, of $2,000 per ton of hydrocarbon emission reductions to decide which controls will be cost-effective. EPA's analyses of refueling and evaporative emission control strategies provide limited documentation to support this standard. Further, EPA's analyses do not consider total benefits and costs of the various strategies, and therefore the analyses are limited as guides to decisionmaking where the strategies being compared achieve different levels of air quality. Further, the analyses do not clearly portray how the ranking of strategies is affected by different assumptions about key uncertain costs and benefits of each strategy. (See ch.4.)

Recommendations

To provide more complete information and analyses to decisionmakers evaluating regulatory alternatives, GAO recommends that the Administrator, EPA, direct the Office of Air and Radiation to include in its refueling and evaporative control analyses

- better documentation of the cost-effectiveness of alternative ozone control strategies, including support for its $2,000 benchmark standard, and
- a more explicit comparison of all the costs and benefits associated with the various refueling and evaporative emission control strategies, including a more thorough analysis of the effects of key uncertainties.

Agency Comments

GAO discussed matters in the report with EPA officials, and their comments were incorporated where appropriate. At the Subcommittee Chairman's request, GAO did not obtain official agency comments on the report's conclusions and recommendations.

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Abbreviations

API	American Petroleum Institute
ASTM	American Society for Testing and Materials
EPA	Environmental Protection Agency
GAO	General Accounting Office
MVMA	Motor Vehicle Manufacturers Association
NHTSA	National Highway Traffic Safety Administration
OMB	Office of Management and Budget
psi	pounds per square inch
RCED	Resources, Community, and Economic Development Division
RIA	Regulatory Impact Analysis
RVP	Reid Vapor Pressure

Introduction

Ozone, often referred to as smog, continues to be one of the nation's most pervasive air pollution problems. Nearly 77 million people live in areas of the country that have failed to attain the federal health standard established for ozone under the Clean Air Act.[1] Scientific research links ozone to reduced lung functions, asthma, eye irritation, and reduced resistance to infection. Ozone also significantly reduces the yield of certain crops and may be a major element in the air pollution that is damaging and killing trees in certain parts of the country.

Unlike other pollutants, ozone is not emitted directly by a particular source. Rather, it is formed as hydrocarbons[2] and nitrogen oxides are emitted by motor vehicles and various stationary sources, such as oil refineries, and chemically react in the presence of sunlight. Because increased air temperature plays a major role in ozone formation, peak ozone levels generally occur during the summer months.

Various measures have been initiated at the federal and state levels to reduce hydrocarbon emissions and control ozone levels. Currently, 37 states have emission limitations for stationary sources as part of their state plan for controlling ozone, covering sources such as factories manufacturing plastic products and gasoline bulk storage tanks. To help the states control stationary source emissions, the Environmental Protection Agency (EPA) has defined control technologies it considers feasible and available for the states to require in controlling these sources. The control technologies apply to about 30 industrial categories. Further, since the mid-1970s, automobiles have been equipped with federally mandated controls for motor vehicle exhaust emissions to reduce hydrocarbons and other air pollutants. To date, 37 states have instituted vehicle emission inspection and maintenance programs to help insure that these controls are functioning properly and to detect any improper maintenance, tampering, or defective equipment problems.

Despite these efforts, hydrocarbon emissions remain a problem, with automobiles, trucks, and other mobile sources continuing to be major contributors. Hydrocarbon emissions in 1983 (the most recent year for

[1] Under Sections 109 and 301 of the Clean Air Act, as amended, the Environmental Protection Agency established a national ambient air quality standard for ozone of .12 parts per million. The act, as amended, requires that all areas attain the standard by December 31, 1987. Currently, there are 76 areas that do not meet the standard. These nonattainment areas can range from a single county to a major metropolitan area.

[2] A class of compounds containing carbon and hydrogen in various combinations and found most abundantly in petroleum, natural gas, and coal.

which EPA has data) totaled about 23.4 million tons, of which 10.7 million tons came from mobile sources. An estimated 60 percent of all mobile source hydrocarbon emissions comes from motor vehicle exhaust, with gasoline vapors from engines and fuel systems making up the remaining 40 percent. The nation's heavy reliance on motor vehicles, combined with the continued inability of many areas to meet the ozone standard, has prompted EPA to look to reducing gasoline vapor emissions from motor vehicles as part of its overall effort to bring all areas into attainment with the federal ozone standard.

Gasoline Vapor Emissions and EPA's Efforts to Control Them

Gasoline vapor emissions from motor vehicles are classified into two categories—refueling and evaporative. As the name implies, refueling emissions occur during vehicle refueling as gasoline vapors in the vehicle fuel tank are displaced by the incoming fuel, forced out of the tank, and escape into the outside air. Evaporative emissions occur when gasoline in the vehicle fuel tank and carburetor (or fuel-injection system) evaporates because of temperature increases caused by the outside air or heat from the engine. Evaporative emissions make up the bulk of gasoline vapor hydrocarbon emissions from mobile sources, accounting for 33 of the 40 percent of emissions coming from such sources. The remaining 7 percent are refueling emissions.

In addition to polluting the air, gasoline vapors pose a health risk to anyone breathing them. These vapors contain benzene, a known carcinogen, and recent studies suggest that the vapors themselves—apart from the benzene component—may be carcinogenic.

Refueling Emissions

At present, there are no federal standards or controls for emissions occurring during vehicle refueling. EPA has been examining ways of controlling refueling emissions since 1973, when the agency began considering the feasibility of installing specialized vapor recovery equipment on service station gasoline pumps (stage II controls). Between 1973 and 1977, EPA approved plans for air pollution control that included stage II controls for all or portions of the District of Columbia and seven states—California, Colorado, Maryland, Massachusetts, New Jersey, Texas, and Virginia—to help reduce automobile pollutants. However, EPA never set final compliance dates for these stage II controls primarily because 1977 amendments to the Clean Air Act required EPA to determine the feasibility and desirability of controls on automobiles (onboard controls) as an alternative to stage II controls. As a result, in 1977 EPA expanded its study of refueling emission controls to include onboard controls. In 1981, EPA announced that, because of the automobile industry's poor financial condition, it would not require onboard technology to control refueling emissions.

In 1983, EPA began to reexamine the refueling emission issue after (1) data became available in 1982 that indicated that gasoline vapors, apart from benzene, may have adverse health effects and (2) two citizens' groups filed suit in 1983 to force EPA action on refueling emissions and related issues. In 1984, EPA issued a regulatory strategies document for the gasoline marketing industry that included a comparison of the costs and benefits of controlling refueling emissions with onboard or stage II controls. Over the last 3 years, EPA has continued to review and revise its refueling control cost and benefit estimates. In the absence of federal action to control refueling emissions, two areas—California and the District of Columbia—have implemented stage II controls to reduce refueling emissions, and St. Louis, Missouri, is also installing them.

Evaporative Emissions

Currently, all gasoline-fueled vehicles are equipped with control systems designed to capture most evaporative emissions. These control systems are to meet specific federal standards based on emission tests using a special certification gasoline. In recent years, oil refineries have added butane and other low-cost ingredients during their fuel production to reduce refinery costs and to replace lead, which is currently being phased out of commercial gasoline. Consequently, the volatility level of the commercial gasoline has steadily increased beyond the volatility level of the test gasoline used to certify these systems. The increased volatility has, in turn, produced more evaporative hydrocarbon emissions than the systems can handle, causing excess emissions to be released into the air.

In November 1985, EPA issued a regulatory strategies document that compared the costs of controlling excessive evaporative emissions by reducing the volatility of commercial gasoline only, or by equating the volatilities of commercial and certification gasoline at the commercial level, the certification level, or at some point between these two levels. Equating the volatilities of the two fuels at a level above the current certification level would have the effect of requiring larger evaporative canisters on new vehicles. In its November 1985 study, EPA concluded that the volatility of commercial and certification gasoline should be the same, but it made no recommendations as to what that volatility level should be.

In March 1987, EPA submitted to the Office of Management and Budget (OMB) its proposed strategies for regulating refueling and evaporative emissions.[3] To reduce refueling emissions, EPA proposes to require onboard controls in the 1990 vehicle model year. To reduce evaporative emissions, EPA proposes to lower the volatility of commercial gasoline during the summer months, beginning in 1989. The EPA Administrator announced on July 22, 1987, that these proposals would soon be published in the Federal Register for public comment.

Objectives, Scope, and Methodology

From January 1986 through January 1987, the Chairman, Subcommittee on Oversight and Investigations, House Committee on Energy and Commerce, wrote EPA nine letters requesting responses to questions about EPA efforts involving fuel volatility and evaporative and refueling emissions. Many of the questions were prompted by our December 1985 report to the Chairman, Air Pollution: EPA's Strategy to Control Emissions of Benzene and Gasoline Vapor (GAO/RCED-86-6), which included a discussion of the issues facing EPA in its decision to control gasoline vapor emissions during vehicle refueling. The Chairman directed EPA to provide us with copies of its responses so that we could review them and report to the Subcommittee. We initially agreed with the Chairman's office to provide the Subcommittee with information regarding EPA's analysis of the feasibility to control evaporative emissions by limiting gasoline volatility and/or enhancing existing vehicle control systems. We later agreed to expand the scope of our work to include critiquing EPA's analysis of the costs and benefits of controlling refueling emissions by onboard or stage II controls and identifying issues that would assist EPA in making any final regulatory decisions.

We performed our work between August 1986 and April 1987 at EPA's headquarters office in Washington, D.C., and its Motor Vehicle Emissions Laboratory in Ann Arbor, Michigan. Work was also performed at the offices of the American Petroleum Institute (API)[4] in Washington, D.C.; the Amoco Oil Company (Amoco) in Chicago, Illinois; and, at the Motor Vehicle Manufacturers Association of the United States, Inc. (MVMA)[5] in Detroit, Michigan.

[3]EPA's March 1987 proposal included a draft regulatory impact analysis for evaporative emission controls dated May 1987 that is referred to in this report by that date

[4]API represents about 6,000 individuals and 234 companies engaged in all aspects of petroleum-related activities.

[5]MVMA is comprised of members from 11 U.S automobile, truck, and bus manufacturers producing more than 98 percent of all domestic motor vehicles.

EPA's Office of Mobile Sources and Office of Air Quality Planning and Standards are the focal points for the agency's gasoline volatility and evaporative and refueling emissions control activities. We interviewed officials and staff from these offices and EPA's Office of Policy Analysis for information on the agency's estimates of the costs and benefits of the various scenarios for controlling evaporative and refueling emissions, and its plans for rulemaking in these areas. Similar discussions were held with representatives of API, Amoco, MVMA, General Motors Corporation, Chrysler Corporation, Ford Motor Company, American Motors Corporation, Toyota Motor Corporation, and Volkswagen of America, Inc., for the oil refineries' and motor vehicle manufacturers' views on the costs and other aspects of controlling evaporative emissions. For recent information on the volatility levels of commercial gasoline, we interviewed MVMA officials concerning their nationwide semiannual gasoline volatility surveys, and obtained from them data on the results of their most recent surveys.

We reviewed a variety of documents for information on the costs and benefits of various gasoline volatility reduction and evaporative emission control scenarios for controlling excess evaporative emissions, and for insight into EPA's and the oil refineries' and motor vehicle manufacturers' rationale for their respective cost-benefit estimates. Documents reviewed included EPA's November 1985 Study of Gasoline Volatility and Hydrocarbon Emissions from Motor Vehicles; the July 1985 and subsequent Bonner and Moore Management Science reports used by EPA in its volatility and evaporative control analysis; the record of EPA's February 4 and 5, 1986, public hearings on the November 1985 study; and, public comments submitted on EPA's study by groups such as API, Amoco, Chrysler, Ford, General Motors, the State of California Air Resources Board, and the State and Territorial Air Pollution Program Administrators. We also reviewed an April 1986 study of gasoline volatility done for EPA's Office of Policy Analysis for additional perspectives on the cost and feasibility of this alternative.

In addition, we obtained and reviewed published and unpublished versions of EPA documents relating to the costs and benefits of onboard and stage II controls to (1) determine EPA's rationale for these estimates, (2) identify the uncertainties associated with EPA's analysis, and (3) determine how EPA considered and responded to the various comments from the oil and automotive industries and others. Documents reviewed included EPA's July 1984 Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry; its July 1986 draft Evaluation of Air Pollution Regulatory Strategies for Gasoline Marketing Industry—

Response to Public Comments; its August 1986 draft Gasoline Marketing Briefing staff paper; and, an unpublished draft update of EPA's July 1986 cost analysis given to us by EPA's Office of Mobile Sources.

Our analysis covered the cost and benefit figures developed by EPA as of March 1987. While we determined the key factors EPA is considering in its decisions regarding the control of refueling and evaporative emissions, we did not identify a preferred strategy or the one that EPA should select to accomplish this goal. In addition, while we identified the differing opinions that exist between EPA, the motor vehicle manufacturers, the oil refineries, and others regarding the costs and benefits of the different refueling and evaporative control strategies, we did not reconcile the differences or determine the accuracy of the various estimates.

From January through December 1986, EPA gave the Chairman more than 1,000 memoranda, studies, charts, and other documents in response to his questions concerning the agency's efforts in the gasoline volatility and evaporative and refueling emission areas. We reviewed each of these documents for additional information on EPA's activities in these areas. We discussed safety and other related matters regarding refueling emission controls with an official of the National Highway Traffic Safety Administration, Department of Transportation.

In April 1987, EPA provided us with copies of the draft refueling and evaporative emission regulatory impact analyses and notices of proposed rulemaking it had forwarded to OMB for review and comment. We reviewed each of the documents to determine which specific control alternative EPA had proposed and its rationale for selecting each alternative, and to critique the cost and benefit analyses developed by EPA and presented in the regulatory impact analyses.

We discussed the matters contained in this report with EPA officials and incorporated their comments where appropriate. As requested by the Chairman's office, we did not discuss our conclusions and recommendations with EPA officials and did not obtain official agency comments on a draft of this report. Our review was performed in accordance with generally accepted government audit standards.

Automobile Refueling Emissions: Controls on the Vehicle Versus the Gasoline Pump

After nearly 14 years of studying the issue, EPA, in March 1987, forwarded to OMB a proposal that would require onboard controls on motor vehicles as the desired method for controlling refueling emissions. Overall, EPA concluded that onboard controls would provide greater long-term emission reductions than stage II, offer similar or better cost-effectiveness values, reduce cancer incidences more than stage II, and avoid many of the difficulties associated with implementing and administering a stage II control program.

EPA's analysis of alternatives for refueling emission controls considered a number of complex factors: reduction of public health risks; cost; ease of enforcement; emission reductions; and, amount of time needed to implement each alternative. Overall, in electing to propose onboard controls for refueling emissions, EPA faced certain tradeoffs in terms of timeliness, costs, and total emission reductions. EPA continues to face differences between its views and those of the motor vehicle industry and others regarding the costs, implementation times, and safety aspects associated with onboard controls.

This chapter discusses EPA's analysis of the costs and benefits of refueling control alternatives and its rationale for deciding that onboard controls are the preferred approach for controlling refueling emissions. In chapter 4, we assess EPA's refueling control analysis and identify issues that EPA should address in making a final regulatory decision.

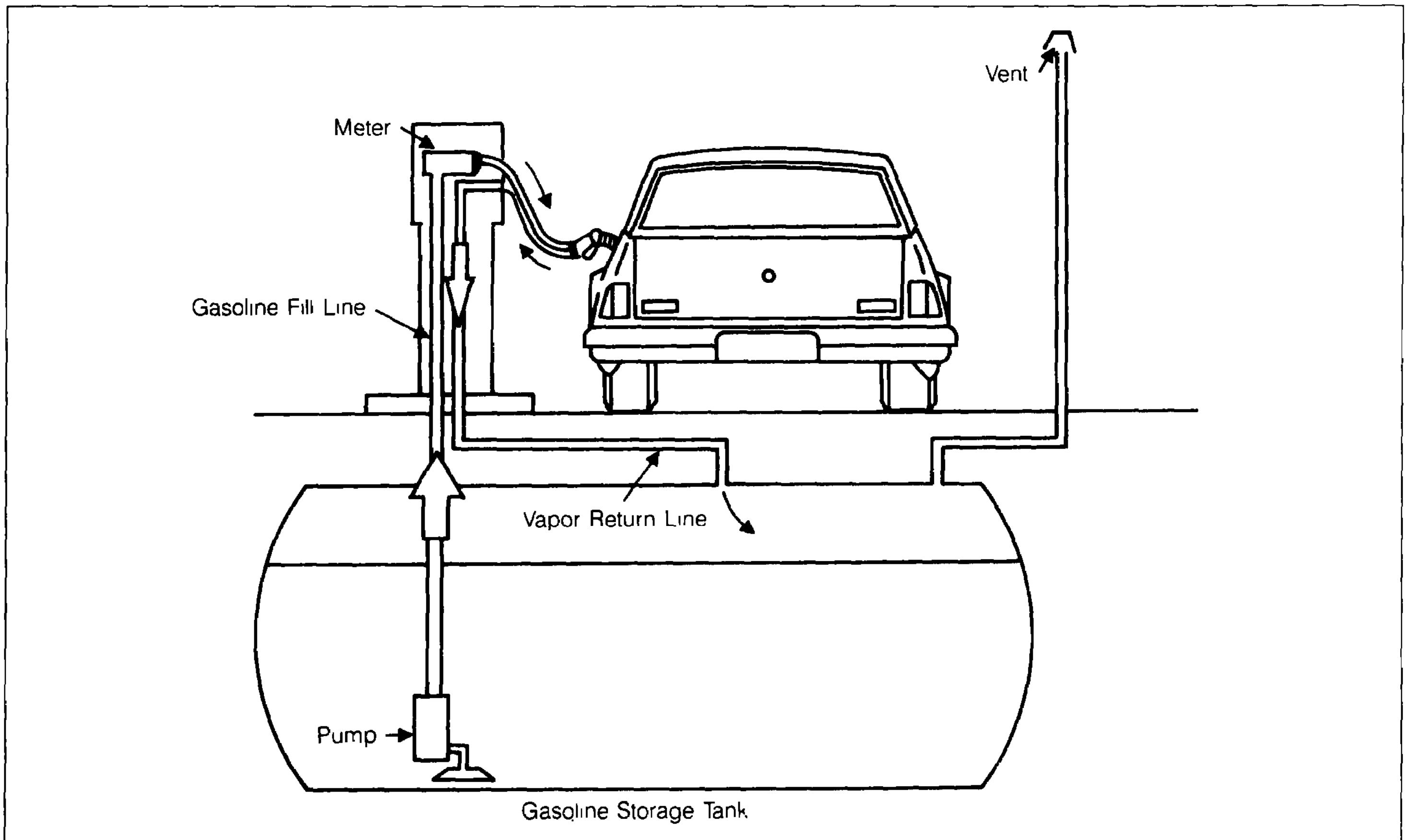
Overview of Refueling Emission Controls

One alternative for controlling refueling emissions involves installing vapor recovery equipment on service station gasoline pumps (stage II controls). Another alternative involves installing vapor recovery equipment on the vehicle (onboard controls).

With stage II controls, gasoline vapors in the vehicle fuel tank are prevented from escaping into the air by a flexible rubber boot, which fits over the standard nozzle on the gasoline hose. The boot traps the vapors as they come up the fuel tank fillpipe, and returns them to the service station's underground storage tank. The vapors replace the gasoline dispensed from the tank and are subsequently transferred to the gasoline delivery trucks as gasoline is pumped into the underground storage tanks during normal fuel delivery operations.

There are currently three types of stage II control systems: the vapor-balance, the vacuum-assist, and the hybrid. The vapor-balance system, which is the simplest and the most commonly used, relies on a tight seal between the boot and the vehicle fillpipe to insure that the vapors are returned to the tank (see fig. 2.1). In the vacuum-assist and hybrid systems, a vacuum pump or the flow of the gasoline itself creates a slight vacuum, which aids in drawing the vapors into the underground tank. Stage II controls have been in use in the District of Columbia and portions of California since the 1970s, and efforts are underway to install stage II controls in the St. Louis, Missouri, area by January 1, 1988. Other states, however, have not adopted stage II controls because they are awaiting a refueling emission decision by EPA or, as in the case of Maryland and Illinois, are precluded by state law from adopting stage II regulations unless required to do so by EPA.

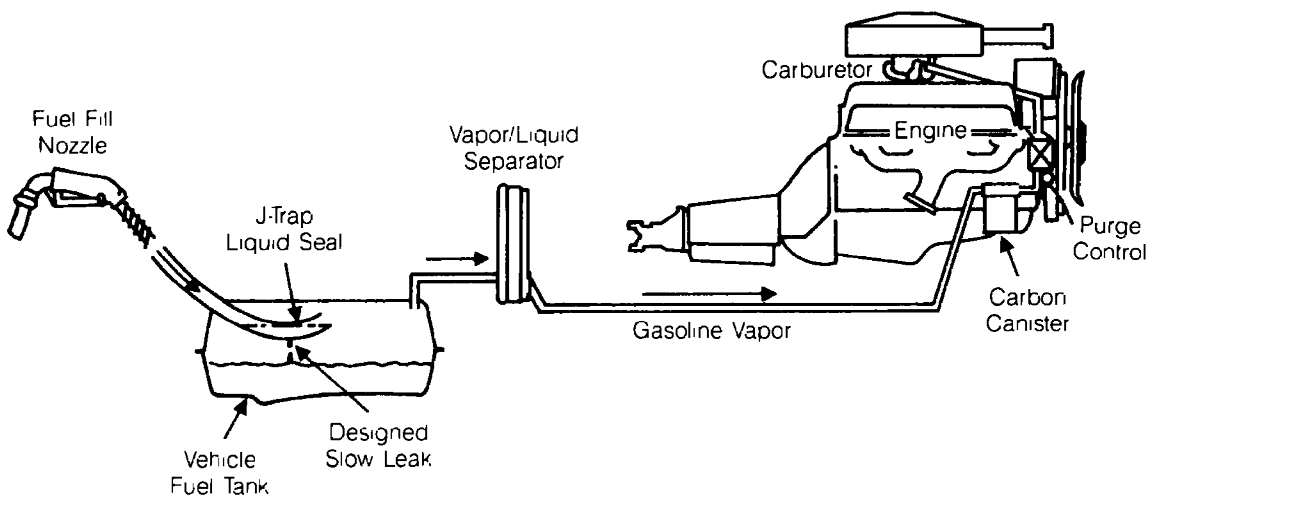
Figure 2.1: Stage II Vapor Recovery Balance System



Source. "The USEPA Regulatory Program," presented by Richard D Wilson, Director, Office of Mobile Sources, EPA, at the 1986 Washington Conference on Ozone Control Strategy, Arlington, Virginia, September 10, 1986.

With onboard controls, gasoline vapors are trapped by a seal in the fillpipe of the fuel tank and stored in a canister mounted on the vehicle (see fig. 2.2). The canister is loaded with granules of activated carbon. As the vehicle is driven, the vapors are purged from the carbon and sent to the carburetor, where they are burned in the engine during normal vehicle operation. Onboard controls, while similar in technology to the evaporative control system, would require (1) a seal in the vehicle fillpipe to prevent the escape of vapors during refueling, (2) an enlarged canister to handle the additional vapors created during refueling, and (3) a larger sized vapor line from the fuel tank to the canister to accommodate the higher vapor flow rate during refueling. Unlike stage II controls, which have been in use since the 1970s, prototype onboard controls have been tested but are currently not being used on automobiles.

Figure 2.2: Onboard Vapor Control System



Source The USEPA Regulatory Program, presented by Richard D Wilson, Director, Office of Mobile Sources, EPA at the 1986 Washington Conference on Ozone Control Strategy Arlington, Virginia September 10, 1986

EPA Analysis of Refueling Emission Controls' Costs and Benefits

EPA's March 1987 draft regulatory impact analysis provides the agency's latest estimates of the costs and benefits of onboard and stage II refueling emission controls. EPA estimates that nationwide onboard controls would reduce emissions by 210,000 megagrams (one megagram is approximately 1.1 tons) a year at an average cost-effectivenessof $850 per megagram; nationwide stage II controls would reduce emissions by 160,000 to 230,000 megagrams per year at an average cost-effectiveness of $810 to $1,060 per megagram. In terms of consumer costs, EPA estimates that nationwide onboard controls would increase the purchase price of the average vehicle by $19, while nationwide stage II controls would add less than one cent to the retail price of a gallon of gasoline. EPA believes that onboard controls have advantages over stage II controls and are the best alternative for controlling refueling emissions.

Chronology of EPA's Efforts to Study the Refueling Problem

In July 1984, EPA completed an analysis of regulatory strategies for controlling gasoline vapors and other air pollutants emitted during the storage, distribution, and retail sale of gasoline. The analysis, which covered the 35-year period from 1986 through 2020, included a comparison of the costs, emission reductions, and health impacts of onboard and stage II alternatives for controlling refueling emissions on a national and regional basis. Overall, the 1984 analysis estimated that, on a nationwide basis,

- onboard controls would reduce emissions by 140,000 megagrams a year at an annualized cost of $199 million;
- stage II controls would reduce emissions by 100,000 to 150,000 megagrams a year at an annualized cost of $146 million to $183 million, depending on whether gasoline stations were inspected annually or not at all; and
- onboard controls would add an average of $15 to the price of a new car or truck, while stage II controls would increase the price of gasoline from 0.25 to 0.74 cents per gallon.

The analysis showed that instituting stage II controls only in those areas in nonattainment with the ozone standard at the end of 1982 would reduce gasoline vapors by 40,000 to 60,000 megagrams a year at an annualized cost of $52 million to $62 million.[1]

In developing these estimates, EPA assumed that (1) nationwide onboard controls would first appear on the 1988 model year vehicles and cover

[1] The study did not specify the number of nonattainment areas.

the entire motor vehicle fleet in about 20 years; (2) initial installation of nationwide stage II controls would begin in 1987, with a national program in place in 1989; (3) onboard controls would have an operational efficiency of 92 percent; and (4) stage II's operational efficiency would range from a high of 86 percent (based on annual enforcement inspections) to a low of 56 percent (based on no enforcement inspections). In addition, in estimating the stage II costs and benefits, EPA assumed that independently owned service stations and company-owned stations with monthly gasoline sales of less than 50,000 and 10,000 gallons, respectively, would be exempted from stage II controls.[2]

In August 1984, EPA released the results of its analysis for public review and comment. Between August and November 1984, EPA received over 180 comments from motor vehicle manufacturers, oil companies, and others, such as state air pollution control officials. EPA spent the next 2-1/2 years reviewing and revising its estimates of onboard and stage II costs and benefits on the basis of the comments it received and the additional work it performed.

In March 1987, EPA prepared a draft regulatory impact analysis, which presented the results of its reanalysis and described the changes made to its 1984 analysis. One change EPA made was to add a separate strategy that considered the reduction in excess evaporative emissions that would occur by enlarging the canisters presently on vehicles to control evaporative emissions. EPA compared the costs and benefits of controlling excess evaporative emissions by expanding evaporative emission canisters by itself and in combination with onboard and stage II controls. EPA noted that since onboard controls would control both refueling and excess evaporative emissions, it would be better to compare the costs and benefits of onboard and stage II if the costs and benefits of controlling excess evaporative emissions were also included in the analysis. Other changes EPA made in its March 1987 reanalysis include the following:

- Changed the onboard technology evaluated from one that uses a mechanical seal to prevent the vapors from escaping to one that uses a liquid seal. The liquid seal system, according to EPA, improves the system's overall efficiency and safety.

[2]Section 324 of the Clean Air Act exempts from federal stage II controls independently owned service stations with monthly gasoline sales of less than 50,000 gallons. In its analysis, EPA also exempts company-owned stations with monthly gasoline sales of less than 10,000 gallons.

- Changed the onboard control analysis to (1) exempt motor vehicles in California from onboard controls since refueling emissions in that state are already controlled by stage II equipment and (2) include several classes of heavy-duty vehicles not considered feasible for control when the 1984 analysis was performed.
- Increased the operational efficiency estimate of onboard controls from 92 to 95 percent to reflect the improved efficiency of the liquid-seal system.
- Increased the minimal operational efficiency estimate of stage II controls from 56 to 62 percent to reflect the latest inspection data for the District of Columbia regarding stage II control efficiency. The maximum efficiency estimate for stage II controls remained at 86 percent.
- Changed the implementation time for stage II controls nationwide from 3 years for all stations to 3 years for company-owned stations and 7 years for independently owned stations to respond to industry concerns that the 3-year period was too optimistic.
- Increased the nationwide annual average gasoline volatility level used to estimate emission levels from 10.0 to 12.6 pounds to reflect the upward trend in commercial gasoline volatility and the increased emission reductions achievable by the different strategies.
- Changed the schedule for decisionmaking and implementation. The date for an EPA regulatory decision on refueling was moved from 1984 to early 1987; the initial implementation for onboard controls went from the 1988 to the 1990 model year vehicle to allow 2 model years to get the systems into production after a regulatory decision; initial installation of nationwide stage II controls moved from 1987 to 1990; and, the analysis period decreased from 35 years (1986-2020) to 33 years (1988-2020).

Table 2.1 summarizes EPA's March 1987 revised estimates of the costs and emission reductions of refueling controls. The estimates show that the average cost-effectiveness of controlling refueling emissions through nationwide onboard controls would be $850 per megagram, while that of nationwide stage II controls would range from $810 to $1,060 per megagram. As table 2.1 also shows, including evaporative emission controls with onboard and stage II controls makes the two strategies more cost-effective. The cost-effectiveness of nationwide onboard controls changes from $850 to $380 per megagram while stage II controls' cost-effectivenesschanges from a range of $810 to $1,060 to a range of $400 to $420 per megagram. This improved cost-effectiveness results because, according to EPA, the value of fuel recovered by the expanded capacity of the evaporative canisters exceeds the costs involved in expanding the canisters, thereby creating a cost savings. However, in its draft notice of proposed rulemaking on refueling emissions, EPA did not include or use the costs and emission reductions that result from expanding evaporative canisters to support its decision to prefer onboard controls. The draft notice stated that EPA believed it was more appropriate to determine the best refueling control strategy without considering the benefits of excess evaporative controls. EPA is considering the control of excess evaporative emissions in a separate rulemaking.

Table 2.1: Impact of Selected Onboard and Stage II Regulatory Strategies (1988-2020)

Regulatory strategy	Annualized emission reductions[a] (ooo megagrams)	Annualized cost (savings)[a] (millions)	Average cost-effectiveness ($/megagram)
Evaporative emission controls by expanding canister	180	($28)	($160)
Stage II controls in 27 nonattainment areas[b,c]	35-70	$38-$60	$850-$1,080
Stage II controls nationwide[b,c]	160-230	$170-$190	$810-$1,060
Onboard controls nationwide	210	$180	$850
Stage II controls nationwide combined with evaporative emission controls[b,c]	330-410	$140-$160	$400-$420
Onboard controls nationwide including evaporative emission controls	380	$150	$380

[a]Annualized emission reductions and cost, as calculated by EPA, represent the 1988 present value for the 33-year period 1988-2020.

[b]Company- and independently-owned stations with monthly gasoline sales of less than 10,000 and 50,000 gallons, respectively, are exempted from control.

[c]Range for stage II strategies reflects different enforcement strategies, ranging from no inspections to annual inspections.

As to the economic consequences of refueling emission controls, EPA's 1987 draft notice of proposed rulemaking estimates that nationwide onboard controls would increase the purchase price of the average vehicle by $19.[1] Nationwide stage II controls, in turn, would raise the retail price of a gallon of gasoline by 0.26 to 0.68 cents. Overall, EPA estimated that refueling controls would reduce emissions by about 2 percent.

[1]EPA's analysis also estimated a $5 credit for recovered vapors, which reduces the net cost to about $14 per vehicle.

EPA Concludes That Nationwide Onboard Controls Have Advantages Over Stage II Controls

In its March 1987 proposal, EPA stated that it considered onboard controls the preferred approach for controlling refueling emissions for several reasons. First, onboard controls would provide greater long-term emission reductions than stage II controls at similar or better cost-effectiveness. As table 2.1 shows, EPA estimates that between 1988 and 2020, nationwide onboard controls would result in annualized emission reductions of 210,000 megagrams a year, at an average cost-effectiveness of $850 per megagram, while nationwide stage II controls would reduce emissions by 160,000 to 230,000 megagrams a year, at an average cost-effectiveness of $810 to $1,060 per megagram. After full implementation in the year 2010, nationwide onboard controls would reduce emissions by 350,000 megagrams compared to a maximum of 280,000 megagrams for nationwide stage II controls.

Second, onboard controls, because of their greater long-term efficiency in reducing emissions, would result in a greater reduction in the number of cancer incidences associated with exposure to benzene and gasoline vapors than stage II controls. EPA estimates that after full implementation in the year 2010, onboard controls would reduce the number of cancers among the general public and service station workers by 53 cases, compared to the maximum reduction of 39 cases for stage II controls.

Third, the onboard technology offers significant advantages over stage II controls and avoids many of the difficulties associated with implementing a stage II control program. Specifically, EPA noted that, compared to stage II controls in nonattainment areas only, onboard controls would provide automatic coverage in all areas of the country, including areas in marginal attainment with the ozone standard, and would help to address the concern that emissions in one area may cause ozone problems in another area. Further, onboard controls could be managed through the existing Federal Motor Vehicle Control Program, whereas stage II controls would result in an extensive new air pollution control program and would be implemented by each of the affected states. In addition, onboard controls would avoid consumer involvement in the control process, compared to stage II controls, which would require the involvement of a number of different parties to be successful. Also, stage II controls, regardless of their design, are heavier, bulkier, and more awkward than conventional fuel pumps and will pose some small inconvenience to consumers. Finally, according to EPA, the installation and maintenance of stage II controls clearly imposes a significant cost burden on service station owners, but onboard control costs would be spread across all the purchasers of new automobiles and trucks. For example, EPA estimates that capital costs to the owner of a typical sixnozzle service station would average $12,200 for vapor recovery controls.

The salient features of onboard and stage II controls are summarized in appendix I. Although EPA has decided that onboard controls are the best alternative for controlling refueling emissions, differences continue to exist between EPA, the motor vehicle manufacturers, and others concerning the cost, implementation time, and safety issues related to onboard controls.

Differences Over Onboard Control Costs, Implementation Time, and Safety Issues

Motor vehicle manufacturers believe that EPA's figures underestimate the cost of onboard controls. As noted earlier, EPA estimates that onboard controls would increase the purchase price of the average vehicle by $19. In contrast, as summarized in table 2.2, motor vehicle manufacturers' estimates range anywhere from $30 per car (General Motors) to $115 per car (Toyota).

Table 2.2: Motor Vehicle Manufacturers' Estimates of Onboard Control Costs

Motor vehicle manufacturer	Cost per car[a]
General Motors Corporation	$30
American Motors Corporation	approx $50
Ford Motor Company	$53
Volvo-North American Car Operations	approx $60
Mazda (North America), Inc	approx $60 to $75
Bayerische Motoren Werke AG (BMW) of North America, Inc	$65
Volkswagen of America, Inc.	$72
Toyota Motor Corporation	$80 to $115
Nissan Motor Company, Ltd	$84 to $110
Chrysler Corporation	$85
American Honda Motor Company, Inc	approx. $90

[a]With the exception of the Toyota Motor Corp and the Nissan Motor Co estimates were provided by the motor vehicle manufacturers in their comments on EPA s July 1984 refueling analysis Toyota's and Nissan's estimates were contained in documents provided to EPA in December 1986 and May 1987 respectively

EPA discussed the differences between its onboard cost estimates and those of the motor vehicle manufacturers in its July 1986 draft response to public comments on its 1984 refueling analysis. Overall, EPA noted at that time that only two manufacturers—General Motors and Ford—provided sufficiently detailed information to enable a comparison with

EPA's estimates. One factor contributing to the difference in estimates, according to EPA, involved the percentage of markup used to account for manufacturer and dealer overhead and profit. EPA's 1984 analysis used a 27 percent markup rate while the manufacturers suggested much higher estimates. Other factors contributing to the different onboard cost estimates included different assumptions about (1) the system's design, (2) the cost of system components, and (3) the cost of designing, assembling, and maintaining the system.

In May 1987, the chief of EPA's Standards Development and Support Branch told us that EPA does not have updated onboard cost information from a majority of the motor vehicle manufacturers. He hopes that the manufacturers will provide such data as part of their comments when EPA issues its proposed refueling regulations for public comment.

Motor vehicle manufacturers also disagree with EPA's estimate of a 2-year implementation time for putting onboard controls into production. MVMA says that a minimum of 4 years will be required to put onboard controls into production, while Toyota maintains that a minimum of 6 years lead time will be needed to hold down the costs associated with vehicle redesign and retooling.

Closely related to the timing issue is the issue of the overall safety of onboard controls, including vehicle fires from crashes and fuel spillage when the vehicle overturns. In January 1987, the Director, Office of Vehicle Safety Standards, National Highway Traffic Safety Administration (NHTSA), Department of Transportation, told us that NHTSA is concerned about whether EPA has given adequate consideration to these potential safety hazards. He said the 2-year lead time anticipated by EPA may not give the motor vehicle manufacturers sufficient time to design, test, and install the onboard controls and to properly address the safety issues that may arise. He estimated that 3 to 4 years will be needed by the motor vehicle manufacturers because of the redesign work that will most likely have to be done to accommodate the onboard controls. Furthermore, in April 1987, during congressional oversight hearings on EPA's efforts to control ozone, the Deputy Administrator for NHTSA testified that the agency had concerns about onboard safety and whether EPA's 2-year lead time estimate will provide the motor vehicle manufacturers with sufficient time to properly address any safety issues. At the same time, this official stated that whether safety problems will actually materialize with the onboard systems will have to await actual system development by the motor vehicle manufacturers.

EPA continues to believe that 2 years is sufficient for motor vehicle manufacturers to design and implement onboard controls, and to meet the necessary safety standards. In a February 19, 1987, letter to Chairman Dingell, EPA stated that its 2-year estimate is based in part on the amount of time motor vehicle manufacturers needed in the past to meet the evaporative emission standards. According to EPA, these standards involved many of the same technological challenges, yet the manufacturers were able to design, develop, and manufacture systems capable of meeting emission and safety standards in this time frame. Further, the emission control and safety technology needed for onboard controls is already being used on vehicles to meet the evaporative emission standards, and this technology can be utilized and expanded to develop effective onboard control systems. In its March 1987 draft notice of proposed rulemaking, EPA reiterated many of these same points and its position that a lead time of 2 years is adequate to design and install onboard controls for the majority of, if not all, motor vehicles.

EPA Faced Tradeoffs in Deciding on a Refueling Emission Control Strategy

EPA's analysis of refueling emission controls compares different control strategies on the basis of a variety of factors including costs, emission reductions, cancer incidence reductions, timeliness, ease of enforcement, and economic impacts. In selecting a strategy that it believes will best control refueling emissions, i.e., onboard controls, EPA had to consider the relative importance of and tradeoffs associated with each of these factors.

Service Station Size Exemption Affects Costs and Benefits of Stage II Controls

In terms of costs versus emission reductions, EPA had to consider the service station exemption policy that it might adopt under stage II controls. Section 324 of the Clean Air Act exempts from federal stage II controls service stations selling low volumes of gasoline. In its March 1987 draft regulatory impact analysis, EPA compared the costs and benefits of nationwide stage II controls under different exemption levels. As table 2.3 shows, lower exemption levels result in greater emission reduction benefits but at a much higher cost. For example, stage II controls that exempt stations selling less than 2,000 gallons of gasoline per month would result in annualized emission reductions of 50,000 to 70,000 megagrams more than stage II controls, which exempt company- and independently owned stations selling less than 10,000 and 50,000 gallons per month, respectively. However, achieving these additional reductions would add from $490 to $600 to the per-megagram cost. Therefore, if EPA had selected stage II controls it would have also had to decide whether the additional emission reductions achievable with fewer exemptions would be worth the additional costs.

Table 2.3: Effects of Service Station Size Exemption on Nationwide Stage II Control Costs and Emission Reductions
(33-Year Analysis)

Exemption level	Range of annualized emission reductions[a] (000 megagrams)	Range of average cost-effectiveness[a] ($/megagrams)
All stations selling less than 2,000 gallons per month	210–300	$1,300–$1,660
All stations selling less than 10,000 gallons per month	200–280	$860–$1,110
Company- and independently owned stations selling less than 10,000 and 50,000 gallons per month, respectively	160–230	$810–$1,060

[a]Range reflects a different enforcement activity, ranging from no inspections to annual inspections

Timeliness Versus Efficiency of Refueling Control Strategies

EPA also faced a tradeoff in weighing the timeliness advantage of stage II controls against the increased emission reduction efficiency of onboard controls. EPA estimates that nationwide stage II controls could be fully implemented in 3 to 7 years, whereas onboard controls would require up to 20 years to equip the entire motor vehicle fleet.

Although taking longer to implement, onboard controls would result in greater benefits in the long term than stage II controls, according to EPA. Stage II controls, under optimum conditions, have a higher in-use efficiency in EPA's analysis than onboard controls until the ninth year, at which time onboard's efficiency surpasses stage II's. Overall, onboard controls would eventually capture about 95 percent of all vapors, while stage II would capture from 62 to 86 percent. In its draft notice of proposed rulemaking, EPA noted that while the benefits of stage II controls may exceed those of onboard during the first few years, the long-term effectiveness of onboard controls is important, given the need to maximize overall emission reductions in light of the nation's long-term problems with ozone nonattainment.

Despite its plans not to require stage II controls, EPA recognizes there may be cases in which it would be reasonable and feasible for states to implement stage II controls in nonattainment areas. These controls would be an interim measure to control refueling emissions while waiting for onboard controls to become operational. According to EPA, the feasibility and reasonableness of such action would depend on the extent to which a state has already planned for or is actually implementing stage II controls. In its draft notice of proposed rulemaking, EPA stated that in those nonattainment areas where stage II controls have already been installed or are in the process of being installed, it would expect the use of these controls to continue while onboard controls are being phased in. In addition, EPA expects that those areas committed to implementing stage II controls in their state plans will either proceed with stage II implementation or submit a state plan revision providing adequate substitute reductions. In other nonattainment areas. EPA's notice of proposed rulemaking states that stage II controls would remain a control measure that states could consider as part of the area's overall strategy for attaining the ozone standard.

Summary and Conclusions

Gasoline vapors emitted during vehicle refueling are, for the most part, uncontrolled. With the exception of the District of Columbia and areas in California, where stage II controls exist, refueling emissions are escaping into the air, where they help to create or add to already existing ozone problems.

In March 1987, EPA submitted to OMB a draft notice of proposed rulemaking for controlling refueling emissions that would require onboard controls. On July 22, 1987, the EPA Administrator announced that this refueling proposal would soon be published in the Federal Register for public comment.

Overall, EPA concluded that onboard controls are the best alternative for controlling refueling emissions because they provide greater long-term emission reductions than stage II, offer similar or better cost-effectiveness values, significantly reduce cancer incidences from refueling emissions, and avoid many of the difficulties associated with implementing and administering a stage II control program.

Although EPA considers onboard controls the preferable method for controlling refueling emissions, it observes that there may be instances where it is feasible and reasonable for states to implement stage II controls in nonattainment areas as an interim measure for controlling refueling emissions while waiting for onboard controls to take effect. We agree with EPA's observation. Stage II controls can be implemented much sooner than onboard, and consequently, could be reducing refueling emissions as onboard controls are taking effect. This interim measure would help reduce ozone levels and possibly bring certain areas into attainment with the ozone standard. Implementing stage II controls would undoubtedly add to the overall cost of controlling refueling emissions. Consequently, any decision to implement such controls would have to be done on a case-by-case basis and consider various factors, including the benefits to be derived compared to the costs involved in implementing interim stage II controls.

EPA's Efforts to Control Evaporative Hydrocarbon Emissions

EPA regulates evaporative hydrocarbon emissions from motor vehicles as part of its ozone control program. However, these emissions continue to pollute the air, helping to increase ozone in some parts of the country to levels considered unhealthy.

Currently, EPA requires that all gasoline-fueled vehicles be equipped with control systems (i.e., canisters) designed to capture the majority of the evaporative hydrocarbon emissions generated in vehicle fuel tanks and carburetors. These control systems are to meet specific federal standards based on emission tests with a certification gasoline of a certain volatility level. Since the introduction of these tests, however, the volatility level of commercial gasoline has increased significantly, while the certification gasoline has remained unchanged. Consequently, most on-the-road vehicles are emitting evaporative hydrocarbons in excess of the allowable federal standards.

In 1983, EPA began studying ways of controlling excess evaporative hydrocarbon emissions. EPA states that this problem can be addressed in the short term by requiring a reduction in commercial gasoline volatility only, and in the long term by equating the volatilities of commercial and certification gasoline at (1) the commercial level, (2) the certification level, or (3) at some point between those two levels. The long-term action would also require modifying vehicle control systems, if the certification gasoline volatility was changed, to ensure that hydrocarbon emissions do not increase. In March 1987, EPA submitted to OMB a draft proposal that supports the short-term approach. It would reduce the volatility of commercial gasoline during the summer months (specifically, May 16 through September 15), when most ozone violations occur, but would allow that volatility to rise during the remaining months. EPA would not change the current certification gasoline volatility, nor would it require modifications to the current vehicle control systems to handle the more volatile commercial gasoline sold during the nonsummer months.

As in the debate over stage II versus onboard controls, the proposal to reduce evaporative hydrocarbon emissions has pitted the motor vehicle industry against the oil refining industry. Officials in the motor vehicle industry favor lowering the volatility level of commercial gasoline to or near the certification gasoline level. In contrast, officials in the oil refining industry support the approach of raising certification gasoline volatility, together with any needed modifications to the control system.

This chapter discusses the rise in commercial gasoline volatility over the past several years and its effect on vehicle control systems and excess evaporative hydrocarbon emissions. The alternatives EPA studied, together with the related concerns expressed by the affected industries, are also discussed. Finally, this chapter examines EPA's draft proposed strategy and the tradeoffs it considered in choosing to reduce commercial gasoline volatility.

Commercial Gasoline Volatility Levels Continue to Rise Above the Certification Gasoline Level

The current federal standards for controlling evaporative hydrocarbon emissions allow vehicle control systems to be tested with certification gasoline having a volatility level ranging from 8.7 to 9.2 pounds per square inch (psi) Reid Vapor Pressure (RVP).[1] For uniformity in the test results, EPA has specified that a 9.0 psi RVP gasoline, rather than a range of volatility levels, be used as the certification gasoline. This RVP level represents the volatility of commercial gasoline sold in the 1970s, when the federal standards were developed. Since then, however, commercial gasoline volatility has risen steadily, causing substantial increases in motor vehicles' evaporative hydrocarbon emissions, especially during the summer months when the ambient temperatures are high.

For the most part, the rise in commercial gasoline volatility has been caused by the oil refineries' increased use of butane and other low-cost, highly volatile ingredients in their gasoline production in response to rising energy costs. These highly volatile ingredients are also being used as octane boosters to replace lead that is now being phased out of commercial gasoline. Volatility data collected over the past two decades suggest this trend to increase gasoline volatility is likely to continue, according to EPA.

Gasoline surveys, performed by the National Institute for Petroleum and Energy Research for the API, show that the summer average RVP for regular unleaded gasoline rose from 9.5 psi in 1974 to 10.8 psi in 1985—a 14 percent increase. (Summer RVP levels were used in those surveys because most ozone violations occur at that time.) In its March 1987 refueling analyses, EPA uses a nationwide weighted average RVP of 12.6

[1] RVP is a measure of a fuel's vapor pressure when tested at 100 degrees Fahrenheit, which is in the usual range of temperatures found in vehicle fuel tanks during the summer. RVP is the most common measure of gasoline volatility.

psi for commercial gasoline. This volatility level is based on the assumption that future summer gasoline RVP will reach 11.5 psi and remain constant, while winter gasoline RVP will exceed 11.5 psi and will approach 14.0 psi in some areas.

No RVP limits are in place to stop this rising trend. Currently, there are only recommended RVP limits, established by the American Society for Testing and Materials (ASTM) in conjunction with the oil refining and motor vehicle manufacturing industries, and those limits are set to prevent vehicle vapor lock at high ambient temperatures and to facilitate engine-starting under cold weather conditions. The ASTM-recommended limits were not established to control excess evaporative hydrocarbon emissions. Furthermore, EPA reports a lack of uniformity in their application and enforcement by the states.

Recommended Volatility Limits Are Not Consistently Applied, Nor Are They Generally Enforced by States

For each month of the year, ASTM assigns each state a "volatility class" or classes (see appendix II) that represents ASTM's best judgment of the optimal gasoline volatility level to ensure the best engine performance. Those states in the warmer climates are assigned lower volatility levels, especially in the summer months. Conversely, those states in the colder climates are assigned higher volatility levels, especially in the winter months.

ASTM has established five gasoline volatility classes, A through E, with class A being the least volatile and class E being the most volatile. Table 3.1 shows the maximum RVP level assigned to each volatility class, as reported by EPA.

Table 3.1: Maximum Volatility Level for Each ASTM Volatility Class

ASTM volatility class	Maximum RVP (psi)
A	9.0
B	10.0
C	11.5
D	13.5
E	15.0

Although these ASTM-recommended levels are not legally binding limits for the commercial oil refineries, they are enforceable in states that have adopted them as part of their own gasoline inspection laws. For instance, during the month of July, when a high number of ozone violations occur, EPA's statistics show that 25 states have laws adopting the

ASTM limits as recommended; 3 states have laws less restrictive than ASTM; and 21 states, as well as Washington, D.C., have no laws specifying RVP limits.

EPA reported in 1985 that enforcement of the RVP limits in most of those states having laws appeared to be ineffective. EPA drew this conclusion from a 1984 MVMA survey of commercial gasoline RVP limits, which showed that over 28 percent of the unleaded regular gasoline sold during the summer in class A and B areas, and over 22 percent of the gasoline sold in class C areas, was above the ASTM-recommended levels. Comparing these survey results with the states having RVP limits, EPA found that roughly one-third of the states were allowing commercial gasoline to be sold with average summer RVP levels above the state-imposed levels. A more recent MVMA fuel survey, conducted in 1985, showed that about 40 to 46 percent of the commercial gasoline sold that year was above the ASTM-recommended levels, indicating the problem continues to increase.

Current Control Systems Do Not Function as Designed With Higher Volatility Gasoline

The widespread differences between the volatility levels of commercial and certification gasoline are a major cause of the problem with excess evaporative hydrocarbon emissions, according to EPA. The currently designed vehicle control systems, certified with a 9.0 psi RVP gasoline, cannot be expected to comply with the federal standards when higher volatility commercial gasoline is used in the vehicles. In fact, EPA tests show that many on-the-road vehicles do not meet the federal standards even with the 9.0 psi RVP gasoline once they have used more volatile gasoline.

A typical vehicle control system for evaporative hydrocarbon emissions consists of a canister filled with carbon granules. The canister collects hydrocarbon vapors as they develop in the fuel tank during daily temperature increases and in the carburetor bowl and fuel lines after the engine has been turned off. Later, when the engine is running, the canister periodically purges with air and releases the trapped vapors into the engine where they are burned as fuel.

Each control system is designed to meet specific standards as outlined in the Code of Federal Regulations (40 C.F.R., part 86). The category of light-duty vehicles, for example, which includes all passenger cars, is required to have control systems emitting no more than 2.0 grams of evaporative hydrocarbons per certification test, using the certification gasoline designated by EPA. According to EPA tests of in-use vehicles, however, such emission limits are generally not being achieved.

From November 1983 to April 1985, EPA tested over 400 vehicles to determine whether they met the 2.0 grams-per-test federal standard after they had been driven on the road for several thousand miles. The EPA tests used both certification test gasoline at 9.0 psi RVP and commercial gasoline at 11.5 psi RVP—the volatility of the gasoline used in the vehicles previously. At both volatility levels, the vehicles tested had average evaporative hydrocarbon emissions greater than the 2.0 grams per test allowed by the federal standards.

For example, when 9.0 psi RVP gasoline was used in tests conducted between July 1984 and April 1985,[2] vehicles with carburetors averaged 4.64 grams of evaporative hydrocarbon emissions per test, and vehicles with fuel-injection systems averaged 2.15 grams per test. In contrast, when 11.5 psi RVP gasoline was used the emissions averaged 12.85 and 7.34 grams per test, respectively.

Concern over these excess evaporative emissions and their effect on the overall ozone problem led EPA, in November 1985, to issue a Study of Gasoline Volatility and Hydrocarbon Emissions from Motor Vehicles. Among other things, this study discussed the (1) current ozone nonattainment problem and seasonal trends in violations; (2) sources of evaporative hydrocarbon emissions; (3) various factors affecting motor vehicle evaporative emissions, such as control system design, gasoline volatility, use of alcohol blends, and ambient temperature conditions; (4) results of EPA's in-use vehicle testing; and (5) evaluation of control strategies to solve the problem of excess evaporative hydrocarbon emissions.

In a November 21, 1985, Federal Register notice, EPA requested public comments on its study; and on February 4 and 5, 1986, the agency held a public hearing in Ann Arbor, Michigan. EPA subsequently revised its November 1985 study to incorporate the comments received from the affected industries and updated the costs of its control strategies. These latest revisions were incorporated into a May 1987 draft regulatory impact analysis (RIA), Control of Gasoline Volatility and Evaporative Hydrocarbon Emissions from New Motor Vehicles.

[2]EPA used different procedures in tests conducted between November 1983 and July 1984, which resulted in greater emission rates with the 9.0 psi RVP gasoline and lesser rates with the 11.5 psi RVP gasoline than in the 1984-85 test period

The following sections discuss the evaporative emission alternatives presented in EPA's 1985 study; the responses presented to EPA and to us by the oil refining and motor vehicle manufacturing industries; and the tradeoffs EPA had to consider in arriving at its proposed gasoline volatility regulation.

Alternative 1: Reduce Commercial Gasoline Volatility

Of the two alternatives EPA considered in its 1985 study, one was to reduce commercial gasoline volatility to a level equal to or nearer that of certification gasoline. EPA, oil refineries, and motor vehicle manufacturers provided varying, and sometimes conflicting, cost and emission reduction estimates for that alternative. Annual cost estimates, for example, ranged from $5 million (for 4-month control at variable RVP levels) to $978 million (for 12-month control at a RVP reduction of 2.5 psi). Similarly, annual emission reduction estimates ranged from 61,000 tons (for 4-month control) to over 1 million tons (for 12-month control).

A reduction of commercial gasoline volatility was the only short-term alternative for reducing evaporative hydrocarbon emissions, according to EPA. Under this short-term alternative, there would be no changes to the certification gasoline RVP and test procedures or to the vehicle control systems. EPA stated that a reduction in commercial gasoline volatility could be achieved most easily by reducing the blending (adding) of butane into the fuel, or by removing part of the butane that is already contained in the fuel stock. Either method would require additional processing to compensate for the octane quality that butane would otherwise provide.

In the 1985 study, Bonner and Moore Management Science[3] estimated that, nationwide, the average cost of reducing commercial gasoline volatility by 1 psi would range from 0.62 to 0.95 cents per gallon. Consequently, Bonner and Moore estimated the cost of a 2-psi reduction at 1.40 to 1.97 cents per gallon. That is, if EPA required refineries to reduce commercial gasoline volatility by 2 psi, consumers would pay about 2 cents more per gallon for their purchases. (The cost estimates presented in the 1985 study assumed a crude oil price of approximately $30 per barrel.)

In addition to those cost-per-gallon estimates, the 1985 study also presented various estimates of the net cost of RVP control in 1988 for 4-month periods (assuming that RVP reductions are needed only during the

[3]Bonner and Moore, under EPA contract, completed three work assignments on gasoline volatility under subcontracts with Southwest Research Institute, for a total cost of $170,000.

summer months when most of the ozone violations occur) and for 12-month periods. Table 3.2 presents these EPA cost estimates, which include refinery costs less fuel economy credits and evaporative recovery credits (i.e., fuel savings) that EPA believed would result from RVP reductions over the short term.

Table 3.2: EPA's Estimated Net Cost of RVP Control in 1988

	Net cost (in millions)	
Level of RVP control (psi)	**4 months**	**12 months**
0.5	$37	$111
1.0	88	262
1.5	162	485
2.0	239	716
2.5	325	978

As a result of these RVP reductions, nationwide hydrocarbon emissions (excluding California, which already has gasoline volatility limits of 9.0 psi RVP) were expected to decrease from about 2 to nearly 8 percent, depending on the RVP control level imposed. Using its projected 1988 emission figures to illustrate the reductions that could be expected, EPA estimated that total hydrocarbon emissions of about 14.3 million tons would be reduced by about 947,000 tons if a 2-psi reduction were imposed over a 12-month period. Over a 4-month period, total hydrocarbon emissions would be reduced by one-third of that amount, or nearly 316,000 tons. Of those reductions, EPA estimated that 72 percent would occur in the motor vehicle evaporative emissions category and the remainder would occur in other emissions categories affected by gasoline RVP control, such as vehicle refueling and exhaust.

Additional cost estimates were provided in another study for EPA's Office of Policy Analysis by Sobotka and Company, Inc. This April 21, 1986, study, Cost and Feasibility of Gasoline Volatility Reductions, indicated that a 2-psi reduction in class C areas only could cost refineries, importers, and distribution centers from $504 million to $622 million annually. For 4-month control, Sobotka estimated that the costs would be approximately one-third of those amounts.

The Sobotka study included a 1988-92 implementation time frame in its cost estimate ranges but pointed out that it would not be possible for oil refineries to reduce RVP by 2 psi in 1988. In the longer term, however, Sobotka believes that refiners should be able to invest in new processing capacity to reach the lower RVP levels, since technology is available to allow reductions to the 9.5 psi RVP level.

Oil Refineries' Cost Estimates for Reducing Commercial Gasoline Volatility Were Much Greater Than EPA's Estimates

In its March 1986 comments on EPA's 1985 study, API proposed that EPA adopt the current ASTM-recommended limits in the summer months as a nationwide regulation. For the most part, then, commercial gasoline volatility limits would be set at levels of 9.0, 10.0, and 11.5 psi RVP, depending on the states involved and the months covered. API's cost estimates are sharply higher than EPA's. Overall, differences occur because API (1) assumed that gasoline in vehicles has an RVP of 0.5 psi below that of dispensed gasoline because of weathering (loss of RVP as evaporation occurs), (2) assumed that gasoline would not have RVP reductions below 9.0 psi, (3) amortized refining cost estimates over a 4-month control period, and (4) used a different approach for modeling butane prices.

API estimated that the additional refinery cost for 4-month summertime control at the ASTM-recommended levels (the only time API believes volatility controls are needed) would amount to $100 million annually. For this control action, API estimated that nationwide hydrocarbon emissions would decrease by about 100,000 tons a year. According to API, commercial gasoline could be refined at the ASTM limits within several months after a regulation was issued.

A reduction of commercial gasoline volatility below the ASTM-recommended levels would not be a cost-effective solution to the ozone and evaporative emissions problems, according to API. However, such reduction might be considered an attractive control measure because it could be achieved in a relatively short time. API believed that such action would impose a tremendous burden on oil refineries. API estimated, for example, that a nationwide summertime volatility reduction to 9.0 psi RVP would require additional refinery processing that, in turn, would increase crude oil imports by 10 percent (i.e., about 350,000 barrels a day) and refinery costs by as much as $970 million a year. An EPA official in the Office of Mobile Sources disputed API's claim, however, stating that about 3 percent more crude oil would be needed to refine the 9.0 psi RVP gasoline, and that amount could be supplied from domestic oil producers' reserve stock.

After allowing for the fuel economy credits and evaporative recovery credits computed by EPA, API further estimated that the overall cost to consumers for the 9.0 psi RVP summer control of gasoline would amount to $650 million annually. That cost is about three to four times greater than the estimated costs presented in EPA's 1985 study for 4-month RVP reductions of 1.5 to 2.0 psi. Those reductions would be equivalent to about a 9.0 psi RVP gasoline, based on the current commercial gasoline volatility levels.

Motor Vehicle Manufacturers' Cost Estimates for Reducing Commercial Gasoline Volatility Were Generally Less Than EPA's Estimates

According to MVMA, the motor vehicle manufacturing industry supports lower volatility for commercial gasoline. The MVMA members could not agree, however, on the particular RVP level.

General Motors Corporation, for example, recommended that EPA impose a regulatory limit of 10.5 psi RVP during the "smog" season (June through September), and then only in areas projected to exceed the ozone standard. This approach, according to General Motors, would bring gasoline volatility down to 9.0 psi RVP in the ozone nonattainment areas because (1) dispensed gasoline would weather in the vehicle tank at the 40-percent full point, causing RVP to automatically decrease about 1.0 psi and (2) refineries would produce commercial gasoline at about 0.5 psi below the regulatory limit in order to assure an adequate margin of compliance. As part of its recommendation to EPA, General Motors assumed that the oil refineries would also comply nationwide with the ASTM-recommended levels in those areas not covered by the regulatory limit.

General Motors estimated that its recommendation, if implemented only in ozone nonattainment areas, would cost from $50 million a year (for $15-a-barrel crude oil) to $113 million a year (for $30-a-barrel crude oil) and result in annual hydrocarbon emission reductions of 61,000 tons. If its recommendation were implemented in all areas, General Motors estimated that it would cost $88 million to $207 million a year, respectively, and result in annual emission reductions of 152,000 tons.

Ford Motor Company, on the other hand, envisioned a regional strategy approach. EPA would place regulatory maximums on gasoline volatility at the ASTM-recommended class A, B, and C levels (i.e., 9.0, 10.0, and 11.5 psi RVP). Ford further envisioned that EPA would ban distribution of class C gasoline during the summer months. In that way, the fuel supply system would distribute less volatile class A or class B gasoline to the current class C areas.

Ford provided EPA with various 4-month control scenarios that estimated, among other things, annual hydrocarbon emission reductions and costs associated with commercial gasoline RVP levels of 9.0, 10.0, and

11.5 psi. Ford considered assumptions that it believed were more realistic than EPA's, and its cost estimates were lower than those in EPA's 1985 study. For example, Ford used a $20-a-barrel crude oil cost instead of EPA's $30-a-barrel cost, which reduced refinery costs by 28 percent. Ford also revised EPA's fuel economy credits and evaporative recovery credits to reflect what it believed to be more realistic fuel savings estimates.

Using its "base case" scenarios at the 9.0 psi RVP level to indicate the effect of those revisions, Ford estimated that net costs would range from $5 million to $96 million a year, which is much less than the cost estimates provided in EPA's 1985 study. For those lower costs, however, Ford estimated that the annual hydrocarbon emission reduction would be 337,000 tons, which is in line with what EPA estimated would result from a similar 2-psi RVP reduction over a 4-month time frame.

Chrysler Corporation, in its evaluation of EPA's 1985 study, stated that the least costly alternative was to reduce commercial gasoline volatility to 9.0 psi RVP, where necessary, to correct ozone nonattainment problems. As did Ford, Chrysler reduced the refinery costs presented in EPA's 1985 study by 30 percent to reflect a $21-a-barrel crude oil price. Chrysler also reduced EPA's fuel economy credits by 40 percent to reflect what it believed to be more realistic values; and, it revised EPA's evaporative recovery credits by 13 to 36 percent to reflect credits taken by EPA in ASTM class A and B areas that Chrysler believed were not warranted.

Compared with EPA's estimates, these changes resulted in significantly reduced cost estimates. For example, Chrysler estimated that a 9.0 psi RVP commercial gasoline level for a 4-month time frame would cost $87 million, which was within the range provided by Ford, but it was only about one-third of that presented by EPA for a 2.0-psi RVP reduction. Chrysler did not comment on the hydrocarbon emission reductions that would occur.

Other motor vehicle manufacturers also agreed that commercial gasoline volatility needed to be reduced. Volvo Cars of North America, Toyota Technical Center, U.S.A., Inc., and American Motors Corporation, for instance, favored a gasoline volatility limit of 9.0 psi RVP, at least during the summer months. These companies, however, did not provide EPA with detailed cost analyses to support their positions.

In its March 1987 proposal, EPA supports this alternative for reducing excess evaporative hydrocarbon emissions. If this proposal is implemented, it will reduce commercial gasoline volatility during the summer months (May 16 through September 15) to a level closer to that of certification gasoline.[4]

Alternative 2: Equate Commercial and Certification Gasoline Volatility and Modify Vehicle Control Systems

In its 1985 study, EPA also provided a long-term alternative for reducing evaporative hydrocarbon emissions that would equate commercial and certification gasoline RVP at some level between 9.0 and 11.5 psi. EPA considered this a long-term strategy because it would (1) require revisions to the existing certification test procedures to account for a more volatile certification gasoline and (2) compel motor vehicle manufacturers to increase the capacity of their vehicle control systems to accommodate the higher emissions. According to EPA, it could take up to 7 years after a regulation takes effect before the modified controls would be installed in half of the vehicle fleet, and up to 20 years before they would be present in almost all of the fleet.

EPA's long-term control scenarios for this alternative considered equating commercial and certification gasoline RVP at 0.5 increments from 9.0 to 11.5 psi RVP. EPA assumed that (1) any commercial gasoline RVP control would be implemented in 1988, (2) any certification gasoline and test procedure revisions would be reflected in the design of the 1990-model year vehicle control system, and (3) a final rulemaking establishing any fuel- and vehicle-related changes would be published in late 1986. (That latter date, of course, has already passed, and EPA's draft RIA extends those time frames.)

Table 3.3, based on estimates provided in EPA's 1985 study, shows the additional costs by vehicle class that EPA estimated consumers would have to pay for new vehicles with the modified control systems if certification gasoline RVP increased from the current 9.0 psi to some level between 9.5 and 11.5 psi.

[4]EPA's proposed gasoline volatility control does not require modifications to the existing vehicle control systems. However, the proposal does include some recommended changes in the evaporative emission test procedures that will require small improvements to the control systems to ensure compliance with the emission standards.

Table 3.3: EPA Estimates of Cost to Consumer for Vehicle Modifications

Vehicle class	Certification gasoline RVP (psi) 9.5	10.0	10.5	11.0	11.5
Light-duty vehicle	$1.50	$1.84	$2 19	$2.53	$2.88
Light-duty truck	1.88	2.39	2 88	3 34	3.80
Heavy-duty truck	1.40	2.14	2 85	3 57	4 20

On the basis of those EPA estimates, the overall cost of a new car (i.e., light-duty vehicle) was expected to increase by less than $3, even in the most extreme case where certification gasoline RVP would be set at 11.5 psi. Such cost, according to EPA, would have no significant impact on vehicle sales.

The 1985 study also provided EPA's estimates, in terms of overall costs and emission reductions, for various long-term control scenarios in the year 2010, when EPA expected that commercial and certification gasoline RVP would be the same, and the vehicle fleet would be turned over (i.e., by 2010, any revised certification gasoline RVP and test procedures would be incorporated into the design of almost all in-use vehicles). To illustrate these overall costs and emission reductions by 12-month and 4-month control scenarios, table 3.4 shows EPA's "base case" estimates, which assumed no vehicle refueling controls and no inspection and maintenance programs for evaporative emissions, since none had been implemented.

Table 3.4: EPA Estimates of Costs and Emission Reductions at Different RVP Levels (psi)

	9.0	9.5	10.0	10.5	11.0	11.5
12-month scenario						
Costs (millions)	$440	$296	$159	$28	$−75	$−160
Emission reductions (thousand/tons)	1,010	925	840	755	669	584
4-month scenario						
Costs (millions)	$148	$56	$−25	$−85	$−126	$−155
Emission reductions (thousand/tons)	337	308	280	252	223	195

The negative costs at 10.0, 10.5, 11.0, and 11.5 psi RVP were based on EPA's assumption that the monetary value associated with fuel economy and evaporative recovery credits would outweigh the refinery and vehicle costs as RVP levels increase. Given this assumption, the 12-month control scenario at the 11.5 psi RVP level was the least costly. It provided for a $160 million overall savings. However, that scenario also provided the lowest emission reductions of all the 12-month control scenarios. Similarly, the 4-month control scenario at 11.5 psi RVP was the least costly and provided the lowest emission reductions of all the 4-month control scenarios.

Oil Refineries Support Higher Volatility Levels

In late 1986, API and Amoco Oil Company representatives told us of an action plan they favored for reducing evaporative hydrocarbon emissions that basically followed EPA's long-term strategy for equating gasoline volatility. Specifically, the plan would have EPA impose a commercial gasoline volatility limit of 11.5 psi RVP between June and September and require that vehicle control systems be designed to handle evaporative hydrocarbon emissions with an 11.5 psi RVP certification gasoline.

Regarding the costs associated with modifying the control systems to handle the 11.5 psi RVP certification gasoline, API accepted EPA's cost estimates of about $3 a vehicle. Amoco's corporate studies director, on the other hand, stated that EPA's cost estimates were too high and the additional carbon and electronic work needed to handle the more volatile gasoline should cost no more than $1 a vehicle.

Marathon Petroleum Company presented its views to EPA on February 4, 1986, stating that the most cost-effective approach for reducing evaporative hydrocarbon emissions was to revise certification gasoline volatility (and consequently modify vehicle control systems) to 11.5 psi RVP. Marathon also supported restrictions on commercial gasoline RVP, provided they (1) apply only during the summer season, when roughly 90 percent of the ozone violations occur; (2) apply uniformly to all oil refiners and marketers, so that small refiners or alcohol blenders do not have an economic advantage; and (3) recognize differences in regional climatic conditions.

Sun Refining and Marketing Company, a subsidiary of Sun Company, Inc., stated that commercial gasoline should be controlled during the "ozone season" but only at ASTM's class A, B, and C levels (9.0 to 11.5 psi RVP). Sun also stated that a certification gasoline should represent future in-use gasoline, and that 11.5 psi RVP was a logical and appropriate design standard to use.

Motor Vehicle Manufacturers Support Lower Volatility Levels

On February 4, 1986, MVMA also provided comments and testified at the EPA hearings on gasoline volatility and hydrocarbon emissions. MVMA concluded that the maximum reduction of hydrocarbon emissions would result from control of commercial gasoline volatility at 9.0 psi RVP.

MVMA raised a number of concerns that apply to any EPA efforts to equate commercial and certification gasoline volatility above the 9.0 psi RVP level. For example, increases in certification gasoline volatility might cause significant increases in exhaust hydrocarbon and carbon monoxide emissions. Further, changes to the certification gasoline and/or test procedures might affect the federal fuel economy standards or evaporative emissions at high altitude.

General Motors told EPA in March 1986 that reducing commercial gasoline volatility to 9.0 psi RVP during the summer would provide twice the hydrocarbon emission reductions of vehicle control system modifications. Furthermore, General Motors' cost analysis indicated that EPA has understated the net costs of vehicle modifications required to control emissions with higher volatility gasoline. Instead of the $3 to $4 cost per vehicle as estimated by EPA, General Motors estimated that the hardware necessary to certify vehicles with 11.5 psi RVP gasoline would cost $25 per vehicle.

General Motors officials also told us in October 1986 that it would take more time to design a control system to handle 11.5 psi RVP certification gasoline than EPA had anticipated in its 1985 study. Further, such a control system—which has not yet been developed—would require much more work than merely enlarging the canister, as EPA suggests. General Motors believes that a minimum of 4 years would be needed (after a final regulation is issued) to design, develop, and test any modified control systems.

Ford Motor Company stated in March 1986 that if EPA adopted an 11.5 psi RVP certification gasoline specification, the size of its vehicle canisters would have to be increased, on average, by 75 percent; electronic purge control valves would have to be added to those vehicles that do not already have them; and, the memory size of its electronic engine control modules would have to be increased. Ford provided no specific cost-per-vehicle estimates for such modifications, but its preliminary analysis indicated that the total costs were twice those used by EPA.

Toyota Technical Center, U.S.A., Inc., commented to EPA in March 1986 that it could take a long time—at least 6 years after a regulation was promulgated—to match its vehicle control systems to the higher volatility gasoline. This time period is due to a variety of problems that would have to be solved, such as the design and installation of a new large canister, evaluation of crash tests to ensure that federal safety standards are met, and preparation for the production of the new systems.

Toyota also believed that vehicle development and production costs would increase much more than EPA's cost estimates indicate. For example, Toyota estimated that the evaporative emission control system and enlarged canister for a vehicle with a carburetor would cost $9.65; for a vehicle with a fuel-injection system the cost would be $7.50.

Similarly, Chrysler Corporation conducted design studies of two types of evaporative control systems using 11.5 psi RVP certification gasoline. It found that the system with the greatest promise had a retail price of $8.29, which was considerably higher than EPA's cost estimates of about $3 to $4 per vehicle.

EPA's Latest Analysis for Controlling Evaporative Emissions Reflects Substantial Revisions

The March 1987 proposal package EPA sent to OMB for review includes an RIA that reflects substantial revisions from the 1985 study. These revisions were made partly in response to the comments EPA received from industry and other interested parties. A major revision involves new analyses of refinery costs using crude oil prices of $25, $20, and $15 per barrel to reflect the recent drop in crude oil prices. EPA also revised its modeling of individual vehicle emissions to (1) account for fuel weathering in vehicle fuel tanks and (2) reflect city-specific summer temperatures for high ozone days rather than one standard temperature estimate. Further, EPA reduced the period of RVP control from 12 months to 5 months. These revisions significantly changed the total emission reductions and cost figures presented in EPA's earlier analysis. In addition to these revisions, EPA considered a number of issues relating specifically to the alcohol fuel industry.

EPA's estimates of long-term (year 2010) emission reductions and costs for nationwide summer control (based on its base-case scenario of $20-per-barrel oil cost), as reported in its draft RIA, are presented in table 3.5.

Table 3.5: EPA Emission Reductions and Cost Estimates in 2010

RVP (psi) level of certification and commercial gasoline	Total emission reductions (000 tons/ year)	Total net costs (millions/ year)[a]
11.5	576	$-25
11.0	616	-13
10.5	655	8
10.0	689	43
9 5	718	95
9.0	748	156
8 5	774	235
8 0	799	316

[a]Minus (-) figures represent savings

As would be expected, reducing the cost of oil reduces the cost of controls significantly. For instance, EPA's figures show that for the first 1-psi reduction in commercial gasoline volatility, the nationwide costs under a $20-per-barrel scenario is 32 percent less than the cost under the $30-per-barrel scenario presented in the 1985 study.

The draft RIA also shows that, in the most extreme case of an 11.5 psi RVP certification gasoline, the maximum final cost to the consumer for the control system modifications would be $4.71 for a light-duty vehicle, $5.79 for a light-duty truck, and $8.70 for a heavy-duty truck. By amortizing the development and certification costs over a 5-year period, the final cost would be reduced to $3.41, $4.09, and $5.29, respectively. This revised cost reflects an increase of about $1 a vehicle over EPA's 1985 cost estimates.

On the basis of its latest analysis, EPA proposes that, beginning in 1989, from May 16 through September 15 each year, commercial gasoline volatility levels be limited to 8.2 psi in class A areas, 9.1 psi in class B areas, and 10.5 psi in class C areas. For 1992 and beyond, EPA proposes further reductions to 7.0, 7.8, and 9.0 psi, respectively. EPA supports its decision by stating that commercial gasoline volatility controls have the advantage of achieving emission control immediately upon implementation, whereas vehicle-based controls (i.e., increased certification gasoline volatility and modified vehicle control systems) would take years to begin having a real effect.

The proposed strategy will reduce the nationwide hydrocarbon inventory by 6 percent immediately upon implementation in 1989, and by 9 percent in 1992, according to EPA. For this emission reduction, estimated refinery costs will increase by $490 million a year (about 1 cent per gallon of gasoline). Further, the increased energy density of lower volatility commercial gasoline and the recovery of evaporative emissions will result in an estimated cost savings to the consumer of $294 million a year, bringing the net cost to about $200 million a year, or under $20 per vehicle over its lifetime.

EPA believes that its proposed strategy will be very controversial. It expects that the motor vehicle industry will, on the whole, be very pleased that so little is required of them. On the other hand, it expects a strong adverse reaction from the oil industry, which will probably argue that the volatility controls are too costly and the lead time too short.

EPA's Proposed Strategy Involved Complex Tradeoffs

Regardless of the final outcome of EPA's proposed strategy, it is important to realize that EPA faced a difficult policy decision in choosing to reduce commercial gasoline volatility as a means of resolving the excess evaporative emissions problem. EPA could have decided not to control excess evaporative hydrocarbon emissions, allowing the present situation to continue. Such a decision was unlikely, however, for several reasons. EPA had already determined in its 1985 study that significant evaporative hydrocarbons were being emitted from vehicles operating with a commercial gasoline that was more volatile than the gasoline for which the vehicle control systems were designed; thus, EPA had indicated that some type of corrective action was warranted. EPA's cost analyses also suggested that, at a minimum, there were some control options that could reduce evaporative hydrocarbon emissions and lead to economic savings, even without considering the environmental quality improvements that would occur. Furthermore, even though oil refineries and motor vehicle manufacturers disagree on how excess evaporative hydrocarbon emissions should be controlled, both agree with EPA that some rectification of the current situation is in order.

Therefore, EPA made a policy decision to bring the allowable certification test emissions and the actual emissions into closer agreement by proposing a strategy that reduces commercial gasoline volatility. To support and carry out this policy decision, various factors had to be weighed and related to the objectives that EPA desired to achieve through regulation of evaporative hydrocarbon emissions. Relevant factors that were considered in this decisionmaking process included (1) environmental quality, (2) timeliness, and (3) cost.

In making its decision to reduce commercial gasoline volatility, EPA noted that the alternative strategy of raising the volatility of certification gasoline and expanding the vehicle control systems could lead to economic savings. EPA elected to propose reducing commercial gasoline volatility, however, because this approach would remove greater amounts of hydrocarbons and would do so in a manner that is cost-effective when compared with the costs of removal from alternative hydrocarbon sources. In addition, control of commercial gasoline volatility leads to more timely reductions of these emissions.

Summary and Conclusions

On-the-road vehicles are, for the most part, emitting evaporative hydrocarbons in excess of the federal allowable limits, despite the fact that the vehicles are equipped with control systems designed to meet those limits. The excess emissions have in turn helped to create widespread violations of the Clean Air Act's ozone standard.

Excess evaporative hydrocarbon emissions occur primarily because the commercial gasoline used in the vehicles is of a higher volatility level than that of the gasoline used to certify that the vehicles' evaporative emission systems meet the federal standards. When the higher volatility commercial gasoline is used, the vehicle control systems as currently designed cannot be expected to adsorb these emissions.

Excess evaporative emissions can be addressed in the short term by reducing commercial gasoline volatility, or in the long term by equating certification gasoline volatility to a level equal to that of commercial gasoline, according to EPA. The agency recognizes that any increase in certification gasoline volatility will require modifications to the evaporative control systems of new vehicles (i.e., expanded canisters) to compensate for the resulting increase in hydrocarbons.

A November 1985 EPA study provided costs and emission reduction estimates for various fuel- and vehicle-related options to control excess evaporative hydrocarbon emissions. Oil refineries and motor vehicle manufacturers responded to the EPA study by providing their own estimates and recommended actions. EPA then responded to those comments in a draft RIA, and developed a proposed strategy announcing that excess evaporative emissions would be controlled by reducing commercial gasoline volatility. EPA expects its proposal to be controversial.

In March 1987, EPA submitted to OMB its proposed strategy for review. On July 22, 1987, the EPA Administrator announced that the proposal to reduce commercial gasoline volatility would soon be published in the Federal Register for public comment.

The choice between reducing commercial gasoline volatility and modifying vehicle control systems depended to a large degree on the emphasis EPA decided to place on the various factors considered in its analyses. In particular, EPA was faced with tradeoffs between the timeliness of the control, the extent of the evaporative hydrocarbon emission reductions desired, and the cost of the option.

Commercial gasoline volatility controls have the advantage of providing the greatest reduction of evaporative hydrocarbon emissions in the earliest (short-term) time frame. Further, commercial gasoline volatility controls offer the possibility of seasonal controls—during the summer months when most of the ozone violations occur. On the other hand, increased certification gasoline volatility and subsequent modifications to vehicle control systems offer the advantage of enabling vehicles to meet the federal emission standards at a net cost that is lower than the cost associated with reducing commercial gasoline volatility. In fact, in some instances, EPA has shown that this alternative produces overall savings to the consumer. In choosing a proposed strategy that reduces commercial gasoline volatility, timeliness and increased emission reductions were key factors in EPA's decision.

In the following chapter, we offer our observations on the EPA's current analyses that serve as the basis for the agency's choice among alternative strategies.

Refinements to Improve EPA's Economic Analyses of Refueling and Evaporative Control Strategies

EPA's draft analyses of refueling and evaporative emission control strategies provide useful information on the costs and benefits of regulating these emissions. Our critique of EPA's analyses, however, identified several issues that, if addressed, would provide clearer and more comprehensive information as EPA moves forward in its final rulemaking process.

First, the draft analyses provide limited documentation to support the standard, or benchmark figure, EPA uses to decide which refueling and evaporative emission controls will be cost-effective. Second, EPA's analyses, which are based on cost-effectivenessratios, are limited as guides to decisionmaking where the strategies being compared achieve different levels of air quality. Third, the analyses do not clearly portray how the ranking of strategies is affected by different assumptions about key uncertain costs and benefits of each strategy.

Addressing these issues would, in our opinion, help clarify EPA's analyses and provide valuable information to assist the Congress and others in evaluating regulatory strategies for achieving the ozone standard. We recognize that EPA has been studying ways to control refueling and evaporative emissions for years and is currently in the initial stages of its rulemaking process to reduce these emissions. However, because most of the information EPA needs is currently available, dealing with these issues in EPA's final analyses should not, in our opinion, delay the rulemaking process.

Better Documentation of the Cost-Effectiveness of Alternative Strategies Is Needed

EPA demonstrates the cost of different refueling and evaporative control strategies by presenting cost-effectivenessratios, which are the costs of each strategy divided by a measure of its effectiveness, such as tons of hydrocarbon emission reductions. EPA states that the refueling and evaporative strategies it is recommending have reasonable costs because their cost-effectiveness ratios are less than $2,000 per ton of hydrocarbon reductions, which is significantly less than the cost per ton of other strategies being considered for controlling ozone.

EPA's comparison of cost-effectiveness ratios is limited because EPA does not document the basis for the $2,000 figure by identifying the other ozone control strategies to which it is referring, nor the costs and emission reductions associated with these strategies. This information is needed to document the relevance of a benchmark cost-effectiveness ratio for reducing ozone levels at $2,000 per ton, as well as to compare alternative control strategies. In addition, we believe the information would be useful in future regulatory analyses. While EPA officials showed us some unpublished information on the cost-effectiveness ratios of alternative strategies, this information was not included in EPA's draft analyses.

Comparability of Seasonal and Year-Round Controls

One important difference between alternative sources of control is whether they remove hydrocarbons throughout the year or primarily during peak ozone periods. EPA considers this difference in evaluating the cost-effectiveness of alternative evaporative emission control strategies. However, EPA's draft analysis does not clearly portray the implications of this difference for the actual costs of summertime hydrocarbon controls—those now being considered for gasoline volatility.

The $2,000-per-ton benchmark cost used in EPA's analysis is a ratio of the total estimated costs of year-round controls divided by the year-round emission reductions. However, in its draft notice of proposed rulemaking, EPA is proposing fuel volatility controls for summer months only. To make the proposal for fuel volatility comparable in cost per ton to year-round controls, EPA multiplies its estimate of emission reductions in the 5 summer months by twelve-fifths. Because this adjustment increases the estimates of emission reductions without changing the costs of the controls, it has the effect of reducing the reported cost per ton of the volatility controls by nearly 60 percent. That is, if the cost-per-ton ratio for volatility controls is calculated using only the actual summertime emission reductions in ozone nonattainment areas, the cost per ton of the volatility control level EPA is recommending would be about $4,450 instead of $1,854. Thus, the EPA adjustment produces cost-per-ton figures that understate the actual costs of summertime volatility controls.

We believe that EPA should include in its analysis an alternative approach that would more accurately reflect the cost per ton of summertime emission controls. EPA could revise its benchmark cost of $2,000 per ton for year-round controls to reflect the relative importance of summer and non-summer emission reductions. For example, EPA could assign a monetary benefit to non-summer reductions and subtract this amount from the costs of the year-round controls to arrive at a net cost figure. Dividing this net cost figure by summertime emission reductions would result in a cost-per-ton ratio that reflects the cost-effectiveness of summertime controls. This ratio would serve as a more appropriate benchmark for summertime-only controls,[1] and would most likely be higher than EPA's $2,000-per-ton figure.

Comparing Total Benefits and Costs of Refueling and Evaporative Emission Control Strategies

In its analyses, EPA uses cost-effectiveness ratios to evaluate refueling and evaporative emission control strategies. However, these ratios are limited as guides to decisionmaking where the strategies being compared achieve different air quality objectives. As an alternative method of analyzing the different strategies, EPA could calculate net benefits, which are the total benefits of the regulation minus the total costs. This method provides a more comprehensive comparison of alternatives when different types of benefits are involved. In addition, net benefits analysis is a better guide when choosing among strategies that provide different levels of control at different costs. Calculating net benefits of the refueling and evaporative strategies should not, in our opinion, delay the rulemaking process because EPA has already collected the information needed to conduct the analysis.

EPA uses cost-effectiveness ratios to determine the least costly way to reduce hydrocarbon emissions in nonattainment areas while taking into account the other benefits associated with the controls, such as attainment area hydrocarbon reductions and reduced cancer incidences.[2] However, examining these ratios does not indicate to what extent the strategies achieve the relative air quality objectives. For example, a strategy that has higher costs per megagram of emission reductions might also achieve a greater volume of reduction. If these additional reductions are judged to be important, that strategy may be preferred despite its higher cost-effectivenessratio.

[1] As discussed in the next section, EPA uses a similar procedure to adjust its cost-effectiveness values for emission reductions that occur in ozone attainment areas.

[2] For example, in the refueling analysis, EPA assigns a value of $7.5 million per cancer incidence avoided and $250 per megagram of hydrocarbon reduction in attainment areas. EPA then subtracts these values from the cost of the control measure and divides by tons of emission reductions to calculate the cost per ton of hydrocarbon reductions in nonattainment areas.

Presenting Net Benefits of Control Strategies Could Better Assist Decisionmakers and the Public

As an alternative method of analyzing different emission control strategies, EPA could compare all of the benefits, expressed in monetary terms, with all of the costs—by calculating net benefits. Despite uncertainties concerning the monetary value of some benefits, this method can be helpful because it can be used to aggregate different types of benefits, such as ozone control and hazardous pollutant control.[3] In addition, in cases where alternative strategies provide different levels of control at different costs, the net benefits approach provides a more straightforward comparison of alternatives than does the cost-effectiveness approach because it explicitly considers the value that society places on achieving the benefits of pollution control. Further, in situations where considerable controversy exists about the costs and benefits of proposed strategies, net benefits analysis can show how the choice of a particular strategy is affected by differing assumptions.

To illustrate the potential usefulness of a net benefits analysis, we calculated net benefits for the proposed refueling and evaporative control strategies using EPA's cost estimates and monetary values for cancer and emission reductions. The following tables present the strategies that our calculations indicate would provide the highest net benefits. The tables do not, however, present the net benefits estimates themselves because our calculations are intended only to illustrate how this method can improve the presentation of results of regulatory analyses.

Table 4.1 shows the refueling strategies that have the highest positive net benefits when certain monetary values are assigned to each category of benefits (cancer incidence and hydrocarbon emission reductions). Decisionmakers and others can use this table to determine how the ranking of strategies is affected by different monetary values. For example, if a value of $2,000 per megagram is assigned to hydrocarbon emission reductions in nonattainment areas, and a value of $3.5 million is assigned to each cancer incidence avoided, then the refueling strategy with highest net benefits is onboard controls. None of the strategies have positive net benefits if the value of a cancer reduction is $2 million or less and the value of hydrocarbon reductions in nonattainment areas is $500 per megagram or less.

[3]Net benefits calculations, as well as cost-effectiveness ratios, are also limited to the extent that they do not reflect factors such as the strategies' distributional impacts on different groups and their likelihood of bringing regions into attainment within statutory deadlines.

Table 4.1: Refueling Strategies With Highest Positive Net Benefits

Value of each cancer avoided	Value of hydrocarbon reductions in ozone nonattainment areas ($/megagram)			
	$500	$1,000	$1,500	$2,000
$0 5 million	None	StII-NA	StII-NA	StII-NA
$2 0 million	None	StII-NA	Onboard	Onboard
$3.5 million	Onboard	Onboard	Onboard	Onboard
$7 5 million	Onboard	Onboard	Onboard	Onboard

Notes

1 The refueling options considered are onboard, stage II nationwide, and stage II in 61 nonattainment areas only (StII-NA) Cost and emission reduction estimates are based on EPA's calculations for the year 2010 by which time EPA assumes any of the strategies could be fully implemented The analysis follows EPA s base case assumption that summertime fuel RVP is 11 5 psi and hydrocarbon emission reductions in ozone attainment areas are valued at $250 per megagram

2 The entry "None" indicates that no strategy has positive net benefits at these benefit values that is, estimated costs exceed estimated benefits

Similarly, table 4.2 shows which gasoline volatility levels, as controls for evaporative emissions, provide the highest net benefits under alternative assumptions about the value of summertime hydrocarbon emission reductions. The table shows two scenarios: (1) volatility levels without refueling controls and (2) volatility levels with onboard controls.[4] The table shows, for example, that if one assumes a value of $4,000 per ton for summertime hydrocarbon emission reductions in ozone nonattainment areas, the volatility level with the highest net benefits would be 9.0 psi RVP with no other controls on refueling emissions, or 9.5 psi RVP with onboard refueling controls. In general, the table shows that when higher benefit values are assigned to summertime nonattainment area hydrocarbon emission reductions, the volatility level yielding highest net benefits decreases.

[4]EPA did not include a scenario with stage II controls. EPA assumes a lower emission reduction credit for volatility controls when combined with onboard controls to avoid double counting because both would control refueling emissions to some extent.

Table 4.2: Fuel Volatility Levels With Highest Positive Net Benefits (Fuel RVP Levels in psi)

	Value of summertime hydrocarbon reductions in ozone nonattainment areas ($/ton)				
	$1,000	$2,000	$3,000	$4,000	$5,000
No refueling controls	10.5	10 0	9 5	9 0	9 0
With onboard controls	11.0	10 5	10 0	9 5	9 0

Note The evaporative control options considered are volatility controls between 11 5 and 8 0 RVP in 5 RVP increments, with the corresponding size modifications for canisters Cost and emission reduction estimates are based on EPA's 5-month emission reduction and cost calculations for the year 2010, by which time EPA assumes any of the strategies could be fully implemented Hydrocarbon emission reductions in ozone attainment areas are valued at $250 per ton, as EPA assumes in its analysis

The evaluation of benefits from evaporative emission controls in table 4.2 differs from that of refueling controls in table 4.1 in two ways. First, a value for cancer reductions is not shown for evaporative control strategies in table 4.2 because EPA estimates that these strategies will have little or no effect on cancer incidences. Second, table 4.2 was derived using EPA figures that reflect the emission reductions and costs of summertime volatility controls. Higher monetary benefit values are considered for these summertime emission reductions in table 4.2 than for the year-round reductions evaluated in table 4.1. These higher values are comparable to estimates of control costs that EPA is considering for attaining the ozone standard.[5]

We emphasize that the purpose of the previous discussion is to highlight the usefulness of net benefits analysis as a method of evaluating refueling and evaporative control strategies. It should not be interpreted as prescribing one policy option over another.

EPA Should Indicate the Effects of Key Uncertainties on Its Results

The type of presentation in tables 4.1 and 4.2 can assist decisionmakers by enabling them to examine the ranking of strategies under different assumptions about the benefits of avoiding environmental damages. It can also be used to examine the ranking of strategies under different assumptions about the costs. As noted earlier, there are a number of important uncertainties in EPA's analyses of refueling and evaporative emissions.

[5] For example, the highest value considered, $5,000 per ton, is comparable to the cost implied by multiplying EPA's benchmark for year-round hydrocarbon control, $2,000 per ton, by the twelve-fifths factor that EPA uses to make its 5-month emission reduction estimates comparable to those from 12-month controls

We believe EPA should show how these results depend on key uncertainties in the benefit and cost data. As we concluded in a previous report,[6] presenting uncertainties in EPA's cost-benefit analyses in this way will reveal how the ranking of alternatives depends on what particular estimates a decisionmaker chooses to select from the range of possible values. It can also indicate the degree of precision in the estimates and provide guidance for planning future research efforts to improve the estimates. EPA's analyses examine what effects some uncertain factors might have; however, they do not fully address the concerns we discuss in the next section. Additional analysis of these uncertainties should not, in our opinion, cause significant delay because much of the necessary information is already available.

Monetary Benefit Values

EPA's cost-effectiveness calculations for refueling and evaporative strategies are of limited usefulness because only one monetary value is assigned to each of two important categories of benefits: cancer incidences avoided and attainment area hydrocarbon reductions. A wide range of values for some of these benefits has been estimated by different researchers. Thus, by presenting only one set of values, EPA's analyses do not indicate whether different assumptions could affect the relative ranking of alternative strategies.

In its incremental cost-effectiveness calculations, EPA uses a value of $7.5 million per cancer incidence avoided. However, EPA's guidelines for performing regulatory impact analysis recommend that a wide range of values can be used to determine the sensitivity of the results to this valuation.[7] We incorporated this range in our illustrative net benefits analysis, presented in table 4.1. The table shows that the ranking of strategies is sensitive to the choice of this value.

Another important uncertainty in the comparison of regional strategies (such as stage II in nonattainment areas) and national strategies (such as onboard controls) is the monetary value of reducing hydrocarbon emissions in attainment areas. Under nationwide controls approximately 60 to 65 percent of the hydrocarbon reductions would occur in attainment areas. These reductions may have value because health effects and certain types of welfare effects, such as damage to vegetation, may occur at ozone levels below the current standard. In addition,

[6] Cost-Benefit Analysis Can Be Useful In Assessing Environmental Regulations, Despite Limitations, (GAO/RCED-84-62, Apr 6, 1984)

[7] EPA, "Guidelines for Regulatory Impact Analysis," December, 1983, page 11.

there are a number of regions in the country with ozone levels just below the standard. Controls in these regions may help them avoid exceeding the standard in the future. To characterize the value of these effects in its draft RIAS, EPA adopted a value of $250 per megagram for attainment area hydrocarbon emission reductions in its incremental cost-effectiveness calculations. EPA's rationale for using this value is that it was cited in comments by General Motors.[8] However, preliminary results of EPA's research suggests that the actual value may be larger; a range of $180 to $1,900 per megagram has recently been estimated.

A higher value of attainment area benefits would increase the attractiveness of nationwide controls compared with regional controls and would also increase the attractiveness of more stringent levels of national controls. For example, when a value of $720 per ton is considered, a value that has been discussed by EPA in preliminary research, our illustrative calculations suggest that onboard controls would have the highest net benefits in most of the scenarios presented in table 4.1.

Finally, an uncertainty that is closely related to the distinction between controls in attainment and nonattainment areas concerns the relative values of summertime and non-summer hydrocarbon emission reductions. Because ozone formation is a greater problem during the summer months, the benefits from summertime emission reductions are likely to be higher than the EPA estimates presented earlier in this section, which are based on average year-round benefits. Attributing a higher value to summer emission reductions makes summertime controls such as volatility limits more attractive compared with year-round controls.

Industry Cost and Emission Reduction Estimates

Our illustrative net benefits analysis also suggests that the ranking of strategies on the basis of their net benefits is sensitive to differences between EPA and industry group estimates of emission reductions and costs. To investigate this issue, we considered the estimates presented by the API and motor vehicle industry groups.

When we calculated net benefits of refueling strategies using motor vehicle industry estimates of onboard system costs, we found that stage II in nonattainment areas had higher net benefits than onboard in all the scenarios considered in table 4.1. API's cost-effectiveness estimates, in

[8] EPA, "Draft Regulatory Impact Analysis For Volatility Regulations for Gasoline and Alcohol Blends," pages 6-10.

contrast, imply that onboard controls would have higher net benefits in most scenarios.

Because of different assumptions about baseline evaporative emissions and control costs, API figures for controlling fuel volatility suggest higher costs and lower emission reductions than EPA's estimates. In our example, API's estimates suggest that expanding evaporative canisters with no reduction in the volatility of commercial gasoline would yield highest net benefits. We also considered the impact on the net benefits ranking of evaporative emission reductions and cost estimates provided by General Motors. Using these figures, the analysis of evaporative control strategies suggests that net benefits increase as the certification gasoline volatility is lowered to 9.0 psi RVP.[9] Given the uncertainties surrounding cost estimates, EPA's analysis should indicate the critical values of costs that would change the results of its analysis.

Discounting Costs and Benefits

In general, discounting is a method we believe should be used to compare strategies with different patterns of costs and benefits over time. Using this approach, benefits and costs occurring in the future are discounted, or reduced in value, compared with those occurring in the present. Thus, strategies that provide benefits sooner will appear more attractive when discounting is applied.

The illustrative results summarized in tables 4.1 and 4.2 are based on EPA's undiscounted estimates for the year 2010, by which time EPA assumes that any of these strategies could be fully implemented. Thus, they do not reflect the differences in timing of costs and benefits among various strategies. EPA also presents discounted values that reflect the present value of the costs and benefits of each strategy over the first 33 years of implementation. However, EPA uses only a 10 percent discount rate in its calculations.

To assess the potential importance of discounting, we calculated the net benefits of the refueling strategies using EPA's discounted present value estimates. In several instances where, in the absence of discounting, onboard refueling controls had the highest net benefits, discounting implied that stage II controls in nonattainment areas had highest net benefits. We found that lower volatility levels had higher net benefits

[9]General Motors' scenarios allow dispensed commercial gasoline to have a higher volatility level than the certification gasoline used to test vehicle compliance with EPA emission standards. Therefore, these scenarios do not exactly correspond to EPA's scenarios, which equate the volatility of certification and commercial gasolines

when present value estimates were used. Because discounting may affect the choice of strategies, and because the appropriate rate to use when discounting health effects and other benefits of environmental regulations is controversial, we believe a range of values should be used and the sensitivity of the results should be considered.

Conclusions

EPA's analyses of refueling and evaporative emission control strategies provide useful information on the impacts of regulating these sources of hydrocarbon emissions. However, better documentation on the costs, emission reductions, and timing of other ozone control strategies would help clarify which refueling and evaporative strategies are most appropriate from a cost-effectiveness standpoint. It would also be useful in future regulatory analyses.

In addition, a comparison of all benefits and costs would be helpful for summarizing the benefits and costs of controlling both refueling and evaporative emissions. Such a comparison should show how variations of estimated benefits of hydrocarbon reductions, costs and volumes of these reductions, and discount rates affect the ranking of alternative control strategies. Dealing with these issues should not delay EPA's regulatory process because much of the necessary information is already available.

Recommendations

To provide more complete information and analyses to the public and to assist the Congress and other decisionmakers in evaluating the regulatory alternatives, we recommend that the Administrator, EPA, direct the Office of Air and Radiation to include the following in its refueling and evaporative control analyses:

- better documentation of the cost-effectiveness of alternative ozone control strategies (including support for its $2,000 benchmark standard) and necessary seasonal adjustments, and
- a more explicit comparison of all the costs and benefits associated with the various refueling and evaporative emission control strategies, including a more thorough analysis of the effects of key uncertainties.

Salient Features of Onboard and Stage II Controls

Salient features	Onboard	Stage II
Installation	On motor vehicles	On gasoline pumps
Implementation	Nationwide.	Areas not in attainment with the ozone standard, or nationwide.
Consumer involvement	None Hardware self-contained on vehicle	Yes. Hardware on pumps used during refueling process
Applicability of controls	Gasoline-fueled vehicles	Federal exemption of independently owned service stations selling less than 50,000 gallons per month
Annualized emission reductions	210,000 megagrams.	160,000 to 230,000 megagrams
Cost-effectiveness of control	$850 per megagram of emissions reduced.	$810 to $1,060 per megagram of emissions reduced.
In-use control efficiency	95%	62 to 86%
Implementation time frame	Up to 20 years to cover entire motor vehicle fleet.	3 to 7 years
Control development status	Prototype only (not on production vehicles)	In use in Washington, D C., and portions of California for over 10 years, and currently being installed in St Louis, Missouri
Administration	Managed through existing Federal Motor Vehicle Control Program	Managed through state air pollution control programs

ASTM's Schedule of Fuel Volatility Classes

ASTM's Schedule of Fuel Volatility Classes

State	Jan	Feb	March	April	May	June	July	Aug	Sept	Oct	Nov	Dec
Alabama	D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D
Alaska	E	E	E	E/D	D	D	D	D	D/E	E	E	E
Arizona	D/C	C	C/B	B	B/A	A	A	A	A	A/B	B/C	C/D
Arkansas	D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D
California:												
North Coast	D	D	D	D/C	C	C	C	C	C	C	C/D	D
South Coast	D	D	D/C	C	C	C/B	B	B	B	B/C	C	C/D
Southeast	D/C	C	C/B	B	B/A	A	A	A	A	A/B	B/C	C/D
Interior	D	D	D/C	C	C/B	B	B	B	B	B/C	C/D	D
Colorado	D	D	D/C	C/B	B	B/A	A	A	A/B	B/C	C/D	D
Connecticut	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Delaware	E	E/D	D	D/C	C	C	C	C	C	C/D	D	D/E
District of Columbia	E	E/D	D	D/C	C	C	B/C	B/C	C	C/D	D	D/E
Florida	D/C	C	C	C	C	C	C	C	C	C	C	C/D
Georgia	D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D
Hawaii	C	C	C	C	C	C	C	C	C	C	C	C
Idaho	E	E/D	D	D/C	C/B	B	B	B	B	B/C	C/D	D/E
Illinois:												
N 40° Latitude	E	E	E/D	D/C	C	C	C	C	C	C/D	D	D/E
S 40° Latitude	E	E/D	D	D/C	C/B	B	B	B	B/C	C	C/D	D/E
Indiana	E	E	E/D	D/C	C	C	C	C	C	C/D	D	D/E
Iowa	E	E	E/D	D/C	C	C/B	B	B	B/C	C/D	D	D/E
Kansas	E/D	D	D/C	C	C/B	B	B	B	B	B/C	C/D	D
Kentucky	E	E/D	D/C	C	C	C/B	B	B	B/C	C	C/D	D/E
Louisiana	D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D
Maine	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Maryland	E	E/D	D	D/C	C	C	B/C	B/C	C	C/D	D	D/E
Massachusetts	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Michigan	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Minnesota	E	E	E/D	D/C	C	C	C	C	C	C/D	D/E	E
Mississippi	D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D
Missouri	E	E/D	D/C	C	C/B	B	B	B	B/C	C	C/D	D/E
Montana	E	E/D	D	D/C	C	C/B	B	B	B/C	C	C/D	D/E
Nebraska	E	E/D	D/C	C	C/B	B	B	B	B	B/C	C/D	D/E
Nevada												
N 38° Latitude	E/D	D	D/C	C	C/B	B/A	A	A	A/B	B/C	C/D	D/E
S 38° Latitude	D	D/C	C/B	B	B/A	A	A	A	A	A/B	B/C	C/D
New Hampshire	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
New Jersey	E	E	E/D	D/C	C	C	C	C	C	C/D	D/E	E
New Mexico												
N 34° Latitude	D	D/C	C	C/B	B/A	A	A	A/B	B	B/C	C/D	D
S 34° Latitude	D/C	C	C/B	B	B/A	A	A	A	A/B	B/C	C	C/D
New York	E	E	E/D	D/C	C	C	C	C	C	C/D	D/E	E
North Carolina	E/D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D/E
North Dakota	E	E	E/D	D/C	C	C/B	B	B	B/C	C/D	D/E	E
Ohio	E	E	E/D	D/C	C	C	C	C	C	C/D	D	D/E
Oklahoma	D	D	D/C	C	C/B	B	B	B	B	B/C	C/D	D
Oregon												
E 122° Longitude	E	E/D	D	D/C	C/B	B	B	B	B	B/C	C/D	D/E
W 122° Longitude	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Pennsylvania	E	E	E/D	D/C	C	C	C	C	C	C/D	D	D/E
Rhode Island	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
South Carolina	D	D	D/C	C	C/B	B	B	B	B/C	C	C/D	D
South Dakota	E	E/D	D	D/C	C	C/B	B	B	B	B/C	C/D	D/E
Tennessee	E/D	D	D/C	C	C	C/B	B	B	B/C	C	C/D	D/E
Texas												
E 99° Longitude	D/C	C	C	C/B	B	B	B	B	B	B/C	C	C/D
W 99° Longitude	D/C	C	C/B	B	B/A	A	A	A	A/B	B/C	C	C/D
Utah	E	E/D	D/C	C/B	B/A	A	A	A	A/B	B/C	C/D	D/E
Vermont	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Virginia	E	E/D	D/C	C	C	C	B/C	B/C	C	C	C/D	D/E
Washington												
E 122° Longitude	E	E	E/D	D/C	C	C/B	B	B	B/C	C/D	D/E	E
W 122° Longitude	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
West Virginia	E	E/D	D	D/C	C	C	C	C	C	C	C/D	D/E
Wisconsin	E	E	E/D	D	D/C	C	C	C	C	C/D	D/E	E
Wyoming	E	E/D	D/C	C	C/B	B/A	A	A/B	B	B/C	C/D	D/E

Source ASTM D439 Table 2

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