***THE POTENTIAL IMPACT OF PROPOSED
HAZARDOUS AIR POLLUTANT LEGISLATION
ON THE U.S. REFINING INDUSTRY***

Final Report

Prepared For:

***Office of Planning and Environment
Assistant Secretary for Fossil Energy
U.S. Department of Energy***

***Contract No. DE-AC-01-88FE61679
Task 9***

November 1989

ICF Resources Incorporated

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EXECUTIVE SUMMARY

OVERVIEW

The Administration has recently submitted a Clean Air Act Bill to Congress which would significantly modify the regulatory treatment of industrial hazardous air pollutants (air toxics). The adverse economic impacts of this legislation on the petroleum refining industry could be substantial.

- Depending on how EPA interprets the legislative language, the capital costs of compliance for the proposed bill could range from \$1.3 to \$15.0 billion.
 - At the upper end of the range, costs of this order of magnitude would be over 2.5 times larger than the combined estimated cost of EPA's gasoline volatility (RVP) regulations and the proposed diesel sulfur content regulations.
 - Potential compliance costs could be as much as \$0.40 per barrel processed for large, complex refineries and as much as \$0.50 per barrel for some small, simple refineries. For perspective, total refining costs, including a normal return on investment, are \$4-5 per barrel.
- Because foreign refineries supplying the U.S. will not be affected by the U.S. air toxics regulations, U.S. refineries may not be able to raise prices sufficiently to recover their compliance costs. For this reason, the air toxic legislation may put U.S. refineries at an economic disadvantage relative to foreign competitors.
 - Even under the best petroleum product market conditions, costs of \$0.40 to \$0.50 per barrel processed could reduce U.S. Gulf refiner cash operating margins by as much as 29 percent.
 - Under less favorable market conditions, such as the mid-80's when refiners were losing money, the hazardous air pollutant regulations could greatly increase U.S. refiner operating losses and potentially lead to closure of some marginal refineries.

LEGISLATIVE SUMMARY

The existing process for regulating hazardous air pollutants under the provisions of the Clean Air Act has proven difficult to implement.

- To date, final National Emission Standards for Hazardous Air Pollutants (NESHAP's) have been promulgated for only seven chemicals.
- Currently, the Clean Air Act stipulates that the NESHAP must provide an "ample margin of safety to protect the public health." Determining a margin of safety for individual chemical compounds that is acceptable to industry and environmentalists alike, that is not cost prohibitive, and that can withstand legal challenge has been extremely difficult and time consuming.

Bills have been introduced in Congress by the Administration, Senator Durenberger (S.816), and Congressmen Waxman (H.R.2585) and Dingell (H.R.4). The proposed procedure for controlling hazardous air pollutants in the new bills is substantially different from the existing regulatory approach:

- **Prespecified List** - The air toxic chemicals to be regulated would be listed specifically as part of the legislation, thereby bypassing the process under existing law that requires EPA to formally list a substance as an air toxic before developing a proposed rule.
- **Source Categories** - Rather than regulating individual hazardous air pollutants, the bills would regulate all hazardous air pollutants by source category (e.g., petroleum refineries). EPA would be required to provide the list of major source categories. Regulating source categories would allow EPA to control numerous air pollutants with a single regulation.
- **Level of Control Technology** - Under current law, the control technology required to reduce air toxic emissions is tied to the measure of acceptable risk. In contrast, all of the recently proposed bills contain language requiring the use of the best

available or maximum achievable control technology (BACT or MACT). The bills use different language to describe BACT or MACT, but all require EPA to define them for each source category. Risk would not be a determinant of the control technology required under the proposed legislation.

- **Timing of Risk Determination** - Each of the bills require that after BACT or MACT has been installed, a residual risk determination be made to assess whether further emission controls are required. The risk determination is shifted from the beginning to the end of the regulatory process. Thus, this approach would permit the maximum currently achievable reductions in air toxic emissions to occur prior to the problematic risk determination process that has brought progress to a standstill under current regulations.

The bills introduced differ on two key points:

- The bills differ on the timetable for promulgating regulations for individual source categories.
 - The Waxman bill requires that all of the source categories listed by EPA be regulated within 8 years after the bill becomes law. The Durenberger bill allows 10 years.
 - The Administration and Dingell bills require that fifty percent of the listed source categories be regulated in 7 years, but permit EPA to determine which of the remaining categories warrant regulation based on risk analysis.
- The bills differ on the degree of flexibility granted to EPA in determining whether a significant residual risk exists.
 - The Waxman and Durenberger bills establish a criterion of one-in-one million risk level for the maximum exposed individual.
 - The Administration and Dingell bills authorize EPA to determine the appropriate risk criterion to use.

Oil Industry Response

The oil industry has submitted testimony recommending changes to the proposed legislation to limit its potential stringency:

- Proposes that the level of control technology required by EPA for each source category be commercially available and take cost and risk into account.
- Recommends that the legislation specify a period of at least ten years for control technology use before any modifications are required to comply with a residual risk determination.
- Recommends that residual risk limits be based on the "most plausible" estimates of exposure and potency, rather than the numerical residual risk limits based on the maximum exposed individual in the Waxman and Durenberger bills.

COMPLIANCE COST ESTIMATES

The cost of compliance with the legislation would depend on the definition of BACT or MACT adopted. Based on an analysis conducted by API, compliance costs could be as follows:

- Minimum costs would be incurred if EPA interprets MACT to be equivalent to control measures currently required in California and other non-attainment areas. These measures would include improved inspection and maintenance programs and might have capital costs of only 1.3 billion dollars.
- Maximum costs would be incurred if EPA interprets MACT more aggressively, leading to higher cost control strategies, or if further controls are required as a result of a residual risk determination. Control strategies in this scenario would include the installation of leakless valves and pumps. Total compliance costs could rise to 15.0 billion dollars.
- The compliance cost for the hazardous air pollutant legislation could be over twice as large as the cost of EPA's gasoline volatility and diesel sulfur content regulations.

**A Comparison of Potential
Petroleum Refinery Capital Costs
Due to Various Air Quality Requirements**

ICF Resources estimates that API costs would yield annualized per barrel costs of compliance between \$0.07 and \$0.50 per barrel.

- With a lenient MACT interpretation, compliance costs for refineries were estimated to be about \$0.07 per barrel.
- With a stringent MACT interpretation, compliance costs would vary. Typical refinery costs would range from \$0.31 to \$0.41 per barrel. For a simple refinery, compliance costs would range from \$0.41 to \$0.51 per barrel.

Annualized Cost of Proposed Air Toxics Legislation (Including Operational and Maintenance Costs)

ECONOMIC IMPACT OF REGULATIONS

The impact of these compliance costs would depend on the U.S. refining industry's financial condition during the implementation period and each refinery's financial situation.

- Refineries located in the Gulf Coast provide the marginal barrel of product to other regions, and have tended to have lower profit margins than refineries located in other regions of the U.S., and would be most at risk from the legislation.

Typical Refinery Operating Margins in 1988

U.S. Gulf Refinery Typical Operating Margins

- Refineries in the U.S. Gulf operated at a loss over much of the period from 1984 through 1987 due primarily to declining consumption, excess refinery capacity, and low capacity utilization. Financial performance showed marked improvement in 1988 and 1989 due to rising demand and capacity utilization. Refinery margins should remain strong in the near-term due to strong demand growth and high refinery capacity utilization.

Small, simple refineries with no specialty products or market niche have had worse financial performance than larger, more complex refineries. Most small refineries in the U.S. Gulf that did not make specialty products like asphalt have closed down since 1980.

- In 1987, a generally bad year for the petroleum refining industry, while typical refineries in the Gulf Coast were estimated to have cash operating losses of about \$0.10 per barrel, simple refineries were estimated to have lost about \$0.75 per barrel.
- In 1988, a much better year in general for the refining industry, typical U.S. Gulf refineries were estimated to have cash operating margins of \$1.41 per barrel, while simple refineries were estimated to have continued to lose money, with operating losses of \$0.25 per barrel.

PERFORMANCE

As U.S. Gulf refineries have the lowest operating margins, the proposed air toxics legislation could cause them the most difficulty.

- If EPA interprets MACT to require more costly technology-based improvements, profit margins for typical U.S. Gulf refineries may be sharply cut and some small, simple refineries may be forced to shutdown.
- Under high profitability conditions like 1988, typical U.S. Gulf Coast refinery profit margins are estimated to decline from \$1.41 per barrel to \$1.00 per barrel, a decline of 29 percent. Operating losses for Gulf Coast simple refineries are estimated to increase from \$0.25 per barrel to \$0.75 per barrel. Continued losses of this order of magnitude may cause the few simple refineries in the Gulf Coast to close. (Small, simple refineries account for only about 2 percent of U.S. refining capacity.)

U.S. Gulf Refinery Margins High Profitability

U.S. Gulf Refinery Margins Low Profitability

- Under the low profitability conditions, typical U.S. Gulf refinery operating losses would increase from \$0.10 per barrel to \$0.51 per barrel. Small, simple refineries in the Gulf Coast would see their losses rise from \$0.75 per barrel to \$1.25 per barrel. Continuing losses of this order of magnitude could lead to the closure of small, simple refineries as well as some marginal larger refineries in the Gulf Coast region.

Refiner Impact Conclusions

The hazardous air pollution legislation could have a substantial adverse impact on refinery profit margins. Some marginal refineries could opt to close down.

- The impact of the hazardous air pollutant legislation on U.S. petroleum refineries will critically depend on EPA's interpretation of the Maximum Achievable Control Technology concept.

- The impact of the proposed legislation could be largest in the Gulf Coast region, where profit margins are lower due to strong competition. However, small refineries in isolated locations could also be adversely affected.
- The concurrent imposition of fuel specification regulations will exacerbate the small refinery's plight.
 - Although the costs of fuel specification regulations are incurred by all refiners supplying the U.S. market and can generally be passed on to consumers, they do require that refiners make substantial capital investments.
 - While petroleum refineries may be willing to make the investments required to comply with fuel specification regulations, the concurrent large investments potentially required by hazardous air pollutant legislation and other stationary source regulations may lead marginal U.S. refineries to decide that the early 1990s is a good time to shut down.

I. INTRODUCTION

President Bush has recently introduced new legislation to amend the Clean Air Act. A major component of the President's bill is designed to establish a framework for controlling hazardous air pollutants.^{1/} Three similar bills have also been introduced in Congress. The purpose of this report is to examine the potential impact that these air toxics legislative initiatives could have on the U.S. petroleum refining industry.

While this report focuses on the impact of the air toxic legislative proposals, they represent only one of the many environmental initiatives currently facing the U.S. refining industry. The environmental regulations fall into two general categories: fuel specification limits and stationary source emission limits.

The fuel specification regulations include EPA's recent Phase I Reid Vapor Pressure regulations, which establish limits for gasoline volatility, and EPA's recently proposed regulations designed to limit the sulfur content of diesel fuel. Fuel specification regulations are primarily designed to reduce emissions from many small mobile sources. Stationary source regulations are a fundamentally different form of regulation designed to limit fugitive and waste gas emissions from major point sources. If enacted, the air toxic emission legislation will lead to stationary source regulations.

Hazardous air pollutant regulations, and other stationary source regulations, are likely to have a larger impact on U.S. refineries than fuel specification regulations. Foreign refineries must comply with U.S. fuel specification regulations in order to sell petroleum products in the U.S.. Consequently, U.S. refineries, at least the more efficient ones, should be able to pass on most of the compliance costs associated with fuel

^{1/} In this report, the terms "hazardous air pollutants" and "air toxics" are used interchangeably.

specification regulations. On the other hand, since foreign refineries do not have to comply with U.S. stationary source regulations, they may be able to increase their exports to the U.S., and U.S. refineries may not be able to pass on the compliance costs to consumers. Thus, U.S. refineries will be placed at a competitive disadvantage relative to foreign refineries as a result of hazardous air pollutant regulations.

In addition to the proposed air toxic legislation, U.S. petroleum refineries are currently facing numerous other stationary source regulations designed to control air emissions, waste water, and solid waste. Although these other regulations are not addressed in this report, the impact of the hazardous air pollutant legislation should be viewed within the context of this broad range of environmental regulations.

METHODOLOGICAL OVERVIEW

Because the hazardous air pollutant legislation was only recently introduced in Congress, there is great uncertainty about the regulations that may ultimately result. Additional uncertainty about the proposed legislation stems from the fact that it gives EPA considerable authority and flexibility in developing air toxics regulations. In order to bracket the range of potential impact of the proposed hazardous air pollutant legislation, two alternative regulatory scenarios were used for this study. The definition of the components for these two regulatory scenarios were taken from a recent study undertaken by the American Petroleum Institute (API).^{2/}

The first scenario assumes that the regulations that are passed to enforce the hazardous air pollutant legislation will require refineries to use improved inspection and maintenance procedures and other comparatively low cost compliance strategies. In the

^{2/}American Petroleum Institute and Delta Management Group, "An Analysis of Petroleum Industry Costs Associated with Air Toxic Amendments to the Clean Air Act," October 17, 1989.

second scenario, it is assumed that, in addition to the low cost steps taken in the first scenario, U.S. refineries will be required to use a more costly technology based approach, including leakless valves and pumps, to reduce hazardous air pollutants.

Total capital cost estimates for each scenario were taken from the API study. ICF Resources used the API estimates to develop annualized per barrel compliance cost estimates for two representative refinery types. The cost estimates were then compared to alternative estimates of refiner cash operating margins^{3/} for both representative refinery types to get a financial measure of the potential impact of the hazardous air pollutant legislation on refiner profitability.

The first representative refinery is assumed to be a small, 30,000 barrel per day operation. As shown in Figure I-1, this refinery type consists of a simple crude distillation unit with only limited additional downstream processing capability. Simple refineries such as this tend to make a high proportion of low value products, such as residual fuel oil. They also have less flexibility to adjust product mix to changing market conditions. Consequently, these small, simple refineries tend to have low profit margins. Simple refineries account for only about 6 percent U.S. refinery capacity.

The second representative refinery is larger (100,00 barrels per day), with a more complex downstream processing configuration. This refinery type produces more high value petroleum products, such as gasoline and jet fuel, and less residual fuel oil. This refinery is relatively typical for the U.S. As a group, complex refineries account for about 94 percent of U.S. refinery capacity.

^{3/} Refiner profitability for this analysis was measured as cash operating margins, which are calculated as product revenue less feedstock costs and less operating costs. This is a pre-tax measure of refiner profitability commonly used in the oil industry. For example, the Oil & Gas Journal, a weekly trade magazine, publishes monthly estimates of refiner profit margins using this same measure.

Figure I-1

Configuration for a Representative Simple Refinery

Source: William L. Leffler, Petroleum Refining For the Non-Technical Person, Penn Well Books, Tulsa, 1985.

Figure I-2

Configuration for a Representative Complex Refinery

Source: William L. Leffler, Petroleum Refining For the Non-Technical Person, Penn Well Books, Tulsa, 1985.

In order to estimate refiner petroleum product revenues used in the cash operating margin calculations, product yields were developed for each refinery type based on the assumption that the refineries both process the same high quality crude oil (West Texas Intermediate). The petroleum product yields for each refinery type are presented in Table I-1. These product yields for representative refinery types were developed as part of work performed by ICF Resources and ENSYS Energy & Systems for the Department of Energy's Strategic Petroleum Reserve Office.

Table I-1

Petroleum Product Yields for the Two Representative Refineries

	<u>Simple Refinery</u>	<u>Complex Refinery</u>
Gasoline		
Regular Leaded	11.6%	0.0%
Regular Unleaded	17.4%	32.2%
Premium Unleaded	0.0%	12.5%
Jet Fuel	15.0%	23.0%
Distillate Fuel Oil	29.0%	22.7%
Residual Fuel Oil	27.0%	9.7%
Total	100.0%	100.0%

Source: ICF Resources and ENSYS Energy & Systems based on average refinery yields for simple and complex refineries in the Gulf Coast.

The representative refinery types used for this analysis are not intended to depict a specific, currently operating refinery. Rather the representative refinery types were used to develop reasonable ranges of cost impacts. The key factors that will affect the cost impact of the proposed legislation are detailed in this report. However, for any given refinery, a number of special market factors may apply. In particular, the analysis performed for this report suggests that simple refineries are currently operating at a loss and could be especially hurt by the proposed hazardous air pollutant legislation.

While there are quite a few small, simple refineries in operation throughout the country, many have developed specialty market niches that may provide them with higher profit margins than are calculated for the simple refineries examined in this report. For example, several simple refineries manufacture "specialty" products such as military jet fuel or lubricating oil. These "specialty" fuels may provide a given refinery with higher profit margins than are calculated for the representative simple refineries discussed in this report.

REPORT OUTLINE

The next chapter of this report presents a summary of the alternative air toxic bills recently introduced in Congress. The potential requirements for controlling air toxic emissions embodied in this legislation are compared to the current requirements. A comparison of the key differences in the four alternative air toxic bills is also presented. The third chapter of the report describes two alternative regulatory scenarios that could develop as a result of the air toxic legislation. Representative refinery compliance costs for each scenario are also presented in this chapter. The last chapter of the report examines the potential impact that the air toxic legislation may have on the U.S. refining industry. Key factors that will affect refiner impacts are discussed first, followed by a review of recent and projected refiner profitability trends. Alternative refinery cash operating margin projections are then compared to the compliance cost estimates for the representative refineries.

II. AIR TOXIC LEGISLATION AND REGULATIONS

This chapter presents a summary of recently proposed federal hazardous air pollutant legislation, beginning with a review of the progress that has been made in regulating air toxic emissions under the current Clean Air Act provisions. The air toxic provisions of President Bush's recent proposal are then compared with three other similar bills recently introduced in Congress. The key differences between the President's bill and the Congressional bills are highlighted, preparing the way for the development of alternative regulatory scenarios and related compliance cost estimates in the next chapter.

CURRENT AIR TOXIC LEGISLATION AND REGULATIONS

Section 112 of the Clean Air Act (CAA) contains provisions for the regulation of hazardous air pollutants. Hazardous air pollutants are defined as those to which no ambient air quality standard applies and which result in an increase in mortality or an increase in either serious irreversible, or incapacitating reversible, illnesses.

In order to regulate air toxic emissions under the Clean Air Act, EPA must promulgate National Emission Standards for Hazardous Air Pollutants (NESHAP) for each pollutant to be regulated. The regulatory procedure that EPA must use to promulgate a NESHAP is depicted in Figure II-1.

The EPA Administrator must first list a chemical as a hazardous air pollutant. Once a chemical has been formally listed, EPA can develop a proposed NESHAP regulation to control air emissions of that chemical. Public hearings are then held on the proposed regulations. EPA can then proceed to issue a final rule regulating air toxics emissions incorporating any changes it deems necessary as a result of the public comments.

Figure II-1

**Procedure for Promulgating Air Toxic Regulations
Under the Clean Air Act**

This lengthy procedure for regulating air toxics under the current Clean Air Act language has proved to be difficult to implement. A major stumbling block has been the provision in the Clean Air Act that stipulates that the NESHAP must provide an "ample margin of safety to protect the public health." Determining a margin of safety for individual chemical compounds that is acceptable to all involved parties, and one that is not cost prohibitive, has been difficult. The regulatory process has been greatly hindered by legal challenges throughout, from challenges to the initial listing of the chemical as hazardous, to challenges to the acceptable margin of safety as defined by EPA. As a result, since 1970 final rules have been promulgated for only seven air toxics.

One of these seven regulations controlled fugitive benzene emissions from refinery equipment and from storage vessels. Petroleum refineries were one of the major sources of benzene equipment leaks. Refineries typically also own benzene storage facilities. The lengthy history of the benzene emission rulemaking process provides an example of how difficult it has been for EPA to develop air toxic emission standards under the current CAA authority.^{4/}

Benzene was first listed as a hazardous air pollutant in 1977. EPA issued a proposed rule for regulating benzene emissions from petroleum refineries in 1980 and 1981. After holding public hearings, a final NESHAP for benzene emissions from petroleum refineries was issued in 1984. However, EPA voluntarily remanded the benzene equipment leak rule in 1987 in response to the Supreme Court decision in the Vinyl Chloride case (Natural Resources Defense Council, Inc. v. EPA).^{5/}

In July, 1988, EPA issued a new proposal for the regulation of benzene emissions from stationary sources. In July, 1989, the EPA Administrator announced that a final benzene emission standard would be promulgated in August 1989. The revised standard will regulate benzene emissions on a site-specific basis, rather than using a more rigid risk

^{4/} The following summary of the regulatory history for the benzene NESHAP is based on: Federal Register, Vol. 53, No. 145, pp. 28496-28504, July 28, 1988.

^{5/} The Supreme Court upheld the ruling of the DC circuit court that required EPA to withdraw a proposed revision to a vinyl chloride emission standard. The court ruled that EPA had revised the vinyl chloride standard based on costs and technical feasibility without first determining safe or acceptable emission levels as called for by section 112 of the Clean Air Act. EPA voluntarily remanded the benzene NESHAP because the approach used to develop the benzene rule was similar to the approach disallowed by the Supreme Court in the vinyl chloride case.

standard that would be applied to all sources uniformly.^{6/} In summary, EPA has had to struggle for over 10 years to develop a NESHAP for one air toxic chemical.

The demonstrated difficulties with the regulatory process under the current law have led to the air toxic provisions of President Bush's Clean Air bill and the three similar Congressional bills.

PROPOSED FEDERAL LEGISLATION TO REGULATE HAZARDOUS AIR POLLUTANTS

On July 20, 1989, President Bush presented the Administration's proposed Clean Air Act Amendments of 1989. The proposed bill was subsequently introduced in Congress by Congressman Dingell in the House, as H.R. 3030, and by Senator Chafee in the Senate, as S.1490. Three similar bills were introduced in Congress this session prior to the release of the President's Clean Air legislation. Senator Durenberger introduced an air toxic bill, as S.816, while in the House, Congressman Dingell introduced a bill containing air toxic emission provisions, H.R.4. In addition, Congressman Waxman introduced a comprehensive air toxic bill, as H.R.2585. The Senate bills have been referred to the Committee on Environment and Public Works. The House bills have been referred to the Committee on Energy and Commerce. Congressional hearings on the President's Clean Air bill began in September, 1989.

The President's bill and the three Congressional bills share many features in common. The procedure for regulating air toxic emissions under the four bills is summarized in Figure II-2. The first step in the regulatory process under the proposed legislation would be for the EPA Administrator to specify the major source categories to be regulated. Major sources to be regulated are defined as those that emit more than 10

^{6/} "Inside EPA," Vol. 10, No. 25, June 23, 1989, p. 1.

Figure II-2

**Procedure for Promulgating Regulations
Under the Proposed Amendments to the
Clean Air Act**

tons per year (tpy) of a listed air pollutant or 25 tpy of a combination of listed pollutants. Petroleum refineries will probably be specified as one major source category.

After a source category has been specified, the next step will be to develop a proposed rule for controlling all air toxic chemical emissions from that source category. All of the proposed bills specify that the rules are to require the use of Best Available or Maximum Achievable Control Technology (BACT or MACT) subject to consideration

of cost, other health and environmental air quality impacts, and energy impacts. Industry and the public will be given the opportunity to comment on the proposed rule. A final rule will then be promulgated with changes reflecting the comments received.

After industry has complied with the final rule by installing the best available control technology, EPA will be required to make a residual risk evaluation. The purpose of this evaluation will be to determine whether a significant health risk remains after the installation of MACT. Should EPA determine that a significant health risk remains, further emission controls may be required.

Several of the proposed air toxic bills also would require EPA to promulgate regulations to control air toxic emissions from smaller area sources, such as dry cleaners, that are not regulated by other provisions of the Clean Air Act.

Comparison of Proposed Legislation With Existing Clean Air Act Provisions

The procedure for regulating air toxic emissions as outlined in the Administration's bill and the similar Congressional bills is significantly different from the current approach specified in the existing Clean Air Act provisions. The major differences between the current regulatory process and the process that would be followed under the proposed hazardous air pollutant legislation are as follows:

- **Prespecified List** - The air toxic chemicals to be regulated are listed specifically as part of the legislation, thereby bypassing the process under existing law that requires a chemical to be formally listed as an air toxic before developing a proposed rule. Under the proposed legislation, the EPA Administrator has authority to modify the list of air toxic chemicals.
- **Source Categories** - Rather than regulating individual air toxics, the bills would regulate air toxics by source category. Regulating source categories will allow EPA to control multiple air toxics from individual sources with a single regulation.

- **Determination of Control Technology** - Under current law, the control technology required to reduce air toxic emissions is tied to a measure of acceptable risk. All of the proposed air toxic bills contain similar language calling for the control of air toxic emissions using the best available or maximum achievable control technology (BACT or MACT). Risk is not a consideration at this stage of the regulatory process under the proposed legislation.
- **Timing of Risk Determination** - Each of the bills require that after BACT has been installed, a residual risk determination be made to assess whether further emission controls are required. Thus, the risk determination is shifted to the end of the regulatory process rather than at the beginning.

Comparison of the Alternative Air Toxic Bills

The four proposed bills share the same general approach for regulating air toxic emissions, as outlined in Figure II-2 above. Many of the specific components of the four bills are almost identical. As shown in Table II-1, each of the four bills contains the same definition of major sources: those emitting more than 10 ton per year of one air toxic, or more than 25 tons per year of a combination of air toxics. All of the bills, with the exception of the Durenberger bill in the Senate, contain an almost identical list of approximately 190 air toxic chemicals to be regulated. The list of chemicals in the Durenberger bill is much shorter and requires that the EPA Administrator publish a list, including the bill's list, within 3 months of enactment. Each of the bills calls for the use of BACT or MACT, subject to considerations of cost, other health and environmental air quality impacts, and energy impacts, to control emissions of the listed air toxics from each of the major source categories.

Table II-1

Comparison of the Four Air Toxic Legislative Proposals

	Administration Plan	Dingell H.R. 4	Warman H.R. 2585	Durenberger S. 816
Definition of Major Source	Emits 10 tons/yr of one toxic, or 25 tons/yr of combination of toxics	Emits 10 tons/yr of one toxic, or 25 tons/yr of combination of toxics.	Emits 10 tons/yr of one toxic, or 25 tons/yr of combination of toxics.	Emits 10 tons/yr of one toxic, or 25 tons/yr of combination of toxics.
List of Chemicals	Provides initial list of 191 toxics, allows for listing and delisting by EPA or petitioners.	Provides initial list of 187 toxics, allows for listing and delisting by EPA or petitioners.	Provides initial list of 187 toxics, allows for listing and delisting by EPA or petitioners.	Provides brief list, but EPA within 3 months must publish list including bill's list.
List of Sources	EPA must publish list of major sources within 12 months.	EPA must publish list of major sources within 12 months.	EPA must publish list of major sources within 12 months.	EPA must publish list of major sources within 12 months.
Timetable for Regulations	50% of sources to be regulated by 7 years, remainder by 10 years if EPA determines need.	50% of sources to be regulated by 7 years, remainder by 10 years if EPA determines need.	All major sources must be regulated by 8 years.	All major sources must be regulated by 10 years.
Emissions Standards	Maximum achievable control technology.	Best available control technology.	Best avail. control technology.	"Most stringent" achieved in practice, but may be less stringent for existing sources than for new sources.
Residual Risk	"Unreasonable risk" standard based on health, cost, technical feasibility. Evaluation within 7 years of the promulgation. Additional standards, if needed, promulgated within 2 years.	EPA decides by 7 years after 1st phase regs if remaining risk to health warrants additional 90% reductions. If so, promulgate regs by 2 years after evaluation.	All sources must meet one in million health based standard within 16 to 22 years.	Has one in million health based goal, plus 1-10,000 health based standard.

While adopting the same general approach and sharing some common elements, the President's bill and the Congressional bills differ in some key respects. One such area of difference is the timetable and procedures established for promulgating regulations for the source categories to be regulated. The Waxman bill (H.R.2585) requires that all of the categories listed by EPA be regulated within 8 years after the bill becomes law. The Durenberger bill (S.816) has a longer time frame of 10 years. The Dingell bill (H.R.4) and the Administration bill allow EPA greater flexibility. Both these bills require that fifty percent of the listed source categories be regulated in 7 years, but permit EPA to determine which of the remaining categories warrant regulation. In both bills, regulations for any additional source categories must be promulgated within 10 years.

Residual risk determination is another key area in which the proposed Air Toxic bills differ. Each of the bills stipulates that EPA is to make a residual risk determination within a set time period after promulgation of a source category regulation. The bills differ in the degree of flexibility granted to EPA in determining whether a significant residual risk exists. The Waxman bill and the Durenberger bill establish a one-in-one million risk level for the maximum exposed individual as the criterion to use in determining whether further regulation is warranted. The Administration bill and the Dingell bill require EPA to make a residual risk determination, but do not specify the risk level to be used in making that decision.

OIL INDUSTRY RESPONSE TO PROPOSED AIR TOXIC LEGISLATION

In testimony before Congress, the petroleum industry has made the following recommendations:

- EPA should specify realistic control requirements in making BACT determinations. In addition, the legislation should allow for a usable life of at least ten years for control technology before any modifications are required to comply with a residual risk determination.

- Legislation should not specify numerical residual risk limits. EPA should have authority to determine the appropriate risk limits for each source category.
- Residual risk limits should be based on the "most plausible" estimates of exposure and potency, rather than the narrow measure of risk based on the maximum exposed individual. Consideration should also be given to the quality and uncertainty of the risk estimates.

III. ALTERNATIVE REGULATORY SCENARIOS FOR THE PETROLEUM REFINING INDUSTRY

This chapter of the report presents two alternative regulatory scenarios for controlling hazardous air pollutants from the petroleum refining industry. These scenarios are not intended to represent an assessment of the most likely regulatory developments, nor do they represent the recommended regulatory approach of any agency, institution, or association. Rather the scenarios are designed to bound the range of possible cost impacts that could result. The chapter begins with a discussion of the key regulatory parameters that will determine the scope and cost impacts of any new air toxic regulatory program. This is followed by a description of the two regulatory scenarios. The chapter concludes with a presentation of estimates of the compliance cost of each of the regulatory scenarios.

The process modifications and related total capital and operating and maintenance costs of compliance estimates for each of the regulatory scenarios discussed in this chapter are taken from work prepared by the American Petroleum Institute (API).^{2/} As discussed below, ICF Resources used these API estimates to develop annualized compliance cost estimates for representative refineries.

KEY REGULATORY PARAMETERS

While there are many factors that will affect the ultimate cost impact of any new air toxic legislation on the petroleum refining industry, several key parameters would seem most important. One such key parameter will be EPA's interpretation of the Best

^{2/}American Petroleum Institute and Delta Management Group, "An Analysis of Petroleum Industry Costs Associates with Air Toxic Amendments to the Clean Air Act," October 17, 1989.

Available, or Maximum Achievable, Control Technology (BACT or MACT) concept. Each of the bills call for consideration of cost impacts, other health and environmental air quality impacts, and energy impacts. However, even with these factors explicitly listed, EPA would appear to have broad range of options for interpreting BACT.

The definition of BACT could prove to be as contentious and difficult to define as the "acceptable level of risk" concept used in the current air toxic regulatory process. A number of factors could make the determination of BACT difficult. For example, the age of equipment or differences in production processes could make BACT appropriate for one facility and technically infeasible for another facility. Similarly, regional market differences could make a given control technology cost effective in one location and economically prohibitive for another location. Rapid technological developments could render a control technology that was once considered the best available obsolete in a short time period. Conversely, a new control technology with apparent great promise in the demonstration project stage could eventually prove to be impossible to implement in a full scale commercial plant. Ultimately, the definition of BACT for each source category will be determined in a rulemaking procedure in which industry, environmental groups, and the public will participate. All of the above considerations should be incorporated into the final BACT determination.

A second key parameter that will determine the magnitude of the impact on the petroleum refining industry of any air toxic requirements is the timing and definition of the residual risk determination. As noted in chapter II, two of the bills, (H.R. 2585 and S.816), specify residual risk criteria based on the most exposed individual. The Administration bill and H.R.4 leave the residual risk criteria to be determined by EPA for each source category regulated. More broadly defined risk criteria than the maximum exposed individual approach could lead to fewer and less costly process modifications as part of the residual risk determination.

The timing of the residual risk determination could also affect the ultimate cost impact of air toxic regulations. Any process and operating changes made by a petroleum refinery to comply with air toxic regulations will most likely require significant capital investment. The longer this equipment remains in use the more time a petroleum refining company will have to recover its investment.

The large differences in the compliance cost estimates for the two regulatory scenarios discussed below reflect the uncertainty associated with the definition of Best Available Control Technology. The cost estimates reported below do not include any costs that may be incurred as a result of a residual risk determination.

REGULATORY SCENARIO I

The first regulatory scenario represents a case in which EPA is assumed to interpret the MACT appropriate for controlling air toxic emissions from refineries to be equivalent to control technologies currently required in California non-attainment areas.^{8/} Because of serious air quality non-attainment problems, California has generally more stringent air quality regulations than most other states and the federal government.

The major components of Regulatory Scenario I include:

- Monthly inspection and maintenance of fugitive emission sources
- Modification of cone roof storage tanks
- Installation of vapor recovery systems at all refinery marine loading facilities

^{8/} For example, the South Coast Air Quality Management District has had regulations in place since 1982 that stipulate monthly inspection of pumps, valves, flanges, and compressors at petroleum refineries.

Fugitive emission sources assumed to be subject to the monthly inspection and maintenance program include refinery valves, flanges, pumps, and compressors. The cost estimates for the monthly inspection and maintenance program were calculated relative to a base case in which annual inspection and maintenance programs are in place. Cone roof storage tanks are assumed to be converted to internal floating roof tanks.

REGULATORY SCENARIO II

The second regulatory scenario assumes that MACT is interpreted by EPA to require additional and more costly technologies that are not regularly used by the petroleum refining industry. Thus, all of the compliance costs of the first scenario are also incurred in the second scenario. In addition, in the second scenario incremental costs are also incurred for the following items:

- Leakless equipment to control fugitive emissions
- External and internal floating roofs for non-cone roof tanks

Leakless equipment will be used to replace currently installed conventional valves, flanges, pumps, and compressors. Leakless equipment refers to components which have little or no fugitive emissions. It represents a technology-based solution to fugitive emissions rather than relying solely on improved inspection and maintenance. An example of the leakless equipment considered for this scenario include dual mechanical seal pumps with barrier fluid circulating between the seals. The barrier fluid serves to separate the process stream moving through the pump from the atmosphere.

Leakless equipment has been considered before by EPA as a means for controlling fugitive emissions from petroleum refineries. However, EPA has in the past opted for improved inspection and maintenance as the preferred method for controlling fugitive

emissions due to the higher costs of leakless equipment.^{9/} In comparison, the South Coast Air Quality Management District has recently developed an air quality management plan that requires the use of some leakless equipment in petroleum refineries.^{10/}

REFINERY COMPLIANCE COST ESTIMATES

API's estimate of the total capital cost of compliance for Scenario I is \$1.3 billion. API estimated additional capital costs in Scenario II of \$14.0 billion. API estimates of annualized capital plus operating and maintenance compliance costs for the two scenarios range from \$0.4 billion to \$2.8 billion.

Based on API's cost analysis, ICF Resources has estimated the compliance costs for each scenario for representative simple and complex refineries. As noted in Chapter I, the representative simple refinery is assumed to be a small 30,000 barrels per day operation consisting of a simple crude distillation unit with only limited additional downstream processing capability. The complex refinery makes more high value petroleum products such as gasoline and jet fuel and less low value products such as residual fuel oil.

Capital Costs of Compliance

Table III-1 summarizes the compliance cost estimates developed for the two representative refinery types examined for this analysis. The detailed compliance cost estimates are presented in Appendix A to this report.

^{9/} Leakless equipment was one of the control technologies considered by EPA in promulgating the NESHAP for benzene fugitive emissions. See EPA-450/3-80-032b, "Benzene Fugitive Emissions: Background Information for Promulgated Standards," June 1982.

^{10/} South Coast Air Quality Management District, "Air Quality Management Plan," March 1989.

Table III-1

**Estimated Compliance Costs
For Representative Refineries**

	<u>Scenario I</u>	<u>Scenario II</u>	<u>Combined Scenarios</u>
<u>Simple Refinery</u>			
Capital Cost (MM \$)	\$3.5	\$26.8	\$30.3
Annualized Cost (MM \$) (Including Operation and Maintenance)	\$0.7 - 1.1	\$ 4.7 - 7.4	\$ 5.1 - 8.5
Cost Per Barrel (\$/BBL)	\$0.07 - 0.10	\$ 0.43 - 0.68	\$ 0.50 - 0.78
<u>Complex Refinery</u>			
Capital Cost (MM \$)	\$11.4	\$71.1	\$82.5
Annualized Cost (MM \$) (Including Operation and Maintenance)	\$ 2.7 - 3.9	\$12.3 - 19.0	\$15.0 - 22.9
Cost Per Barrel (\$/BBL)	\$ 0.08 - 0.11	\$ 0.34 - 0.52	\$ 0.42 - 0.63

The capital cost of compliance for the representative simple refinery range from \$3.5 million in Scenario I to \$26.8 million in Scenario II. Because Scenario II costs are additive, the total capital costs of compliance for simple refineries could be as much as \$30.3 million.

Capital costs for compliance could be much higher for complex refineries, ranging from \$11.4 million in the Scenario I to \$71.1 million in Scenario II. Given the additive nature of Scenario II compliance measures, total capital costs for complex refineries could be as high as \$82.5 million.

The two major capital cost categories in the Scenario I are marine vapor recovery systems and conversion of cone roof tanks to internal floating roofs. These two categories account for 95 percent of the total capital costs of compliance for both the representative simple and complex refineries. (See Figure III-1)

In Scenario II, leakless valves, flanges, pumps, and compressors account for 35 percent of the total compliance capital cost for the representative simple refinery and over 60 percent of the capital costs for the complex refineries. Other major capital cost categories in this scenario are: external and internal floating roof tanks; central vapor recovery systems; upgrade of the gas recovery system; and control of flared gases.

Annual Costs of Compliance

Annual compliance costs for each representative refinery type were calculated as the sum of annualized capital costs plus operation and maintenance costs. Annualized capital costs were developed for this analysis using the following formula:^{11/}

$$\text{Capital Cost} * (1 - a) / (1 - a^n)$$

where: $a = 1/(1 + i)$

i = real discount rate of 10 percent

n = assumed usable life of equipment

This formulation yields an annualized cost such that the net present value of the annualized amount paid over the assumed useful life of the equipment will equal the original capital cost.

^{11/} This is the same annualized cost formulation used by API in their recent report on the effects of the air toxic legislation. API, op cit.

Figure III-1

Major Capital Compliance Cost Components
for Representative Refineries

Scenario I

- Marine Vapor Recovery
- ▨ Cone Roof Tanks
- Other:
 - Flares
 - Sewer System Drains
 - Safety Valves Rupture Disk
 - Combustion Engines

Scenario II

- ▨ V, F, P, C (Leakless Valves, Flanges, Pumps, and Compressors)
- ▨ Ext. Floating Roof Tanks
- ▨ Int. Floating Roof Tanks
- Other:
 - Central Vapor Recovery
 - Gas Recovery Upgrade
 - Flares
 - Main Separator Battery
 - Internal Combustion Engines
 - Truck Loading

Per barrel costs were calculated by dividing the annualized capital costs by the daily processing capacity assumed for the representative refineries - 30,000 barrels per day for a simple refinery and 100,000 barrels per day for a complex refinery.

For this analysis, a range of annualized costs and per barrel costs were developed for each refinery type for both scenarios to reflect the effect of different assumptions about the usable life of the installed equipment (n in the above annualized cost equation). The lower estimate of annualized and per barrel costs uses the API's assumption of the usable life for each type of capital equipment. Usable life for different types of capital equipment range from 10 to 20 years. In contrast, the upper bound estimate assumes a usable life of 5 years. This shorter usable life assumption would correspond to a case in which the permit required under the Administration's Clean Air bill for air toxic control equipment is not renewed after the 5 year base period.^{12/}

As shown in Table III-1, in Scenario I annual compliance costs for the simple refinery range from \$0.7 to \$1.1 million dollars and from \$2.7 to \$3.9 for a complex refinery. Thus, annual costs are much lower for a simple refinery than for a complex refinery. However, on a per barrel basis, both simple and complex representative refineries have very similar compliance costs ranging from \$0.07 to \$0.11. Thus, in Scenario I simple refineries incur a smaller total annual cost, but about the same cost on a per barrel basis.

In Scenario II, total capital costs and annual costs estimates show a similar pattern. However, in Scenario II, the representative simple refinery is estimated to incur higher per barrel compliance costs than the representative complex refinery. (See Figure III-2). The simple refinery compliance costs range from \$0.43 to \$0.68 per barrel compared to the complex refineries

^{12/} See section 402(d) (5) (B) of the Administration Bill, which states that " the permitting authority have adequate authority to issue permits for a fixed term, not to exceed five years. . ." This is a sensitivity scenario also used by API in their study on impacts of air toxic legislation. API, op cit., p. 39.

Figure III-2

Comparison of Compliance Costs
for Representative Refinery Types

compliance costs of \$0.34 to \$0.52 per barrel. Much of the higher per barrel costs for simple refineries is due to the larger number of storage tanks required per barrel processed for simple refineries relative to complex refineries.^{13/}

^{13/}Based on the report prepared by Entropy: "Aboveground Storage Tank Survey," final report, April 1989. Simple refineries were assumed to have 82 storage tanks and more complex refineries 126 storage tanks. Thus, simple refineries have 2.7 storage tanks per barrel processed, while complex refineries have only about 1.3 storage tanks per barrel processed. See Appendix A for more details of the calculation of total capital costs and annual costs for each scenario.

CONCLUSION

Depending on how EPA interprets the Maximum Achievable Control Technology legislative language, the capital costs of compliance for the proposed hazardous air pollutant legislation could range from \$1.3 to \$15.3 billion. For comparison purposes, the upper bound compliance cost estimates for the proposed legislation would be nearly 2.5 times larger than the combined estimated costs of EPA's gasoline volatility regulations and proposed diesel sulfur content regulations.^{14/}

^{14/}ICF Resources Inc., "The Effect of Air Pollution Regulations on the U.S. Refining Industry," June 1989. Gasoline volatility regulations were estimated to have capital costs of \$2.4 billion. The proposed diesel sulfur content regulation was estimated to cost \$3.3 billion.

IV. REFINERY IMPACT ANALYSIS

This chapter presents an analysis of the potential impact of the proposed air toxic regulations on the petroleum refinery industry. The chapter begins with a discussion of the key factors that affect refinery profitability. This is followed by a review of the recent financial performance of the refinery industry in general. This section also presents estimates of the profitability of representative simple and complex refineries. Regional differences in the profitability of these representative refineries are also discussed. The next section of the report presents a discussion of likely future trends in refinery profitability.

This discussion sets the stage for an analysis of the effects of the proposed air toxic legislation on the petroleum refinery industry. The compliance cost estimates presented in Chapter III for simple and complex refineries are compared to alternative estimates of refiner profitability.

KEY REFINERY CHARACTERISTICS

The impact of the proposed air toxic legislation on a particular petroleum refining industry will depend on such regulatory parameters as the interpretation of the Maximum Achievable Control Technology and the criterion used for the residual risk determination. (See Chapter III). In addition to these regulatory parameters, the impact of the proposed legislation on a particular refinery will depend on the following refinery characteristics:

- Process configuration and product mix
- Age
- Location

Process Configuration and Product Mix

A simple refinery consisting of an atmospheric crude distillation column and little additional downstream processing capacity will tend to produce a high proportion of relatively low value residual fuel oil. A simple refinery will also tend to have limited capacity to change its product mix to adapt to changes in product or crude oil prices. In contrast, a more complex refinery will tend to produce a higher proportion of high value petroleum products such as gasoline and jet fuel. In addition, a complex refinery will be able to adjust the utilization of its downstream processing units to alter its product mix when changes occur in relative product or crude oil prices. For these reasons, a simple refinery will tend to be less profitable than a more complex refinery in most circumstances.^{15/} Thus, simple refineries with lower profit margins will generally be less financially capable of paying for the compliance costs on any new air toxic regulatory programs.

Simple refineries account for about 5 percent of total U.S. refinery capacity. (See Figure IV-1). However, many of these simple refineries have the capability to make specialty products, such as military jet fuel (JP4), lubricating oils, and asphalt. Simple refineries that produce specialty products will tend to have higher profit margins than simple refineries without that capability. Simple refineries without the capability to make specialty products account for only 2 percent of total U.S. refinery capacity.

^{15/} As illustrated below, more complex refineries have higher operating costs per barrel than simple refineries. Nonetheless, in most market conditions, the additional revenue gained from making higher value products than a simple refinery will tend to more than compensate for the higher operating costs.

Figure IV-1

**Simple Refineries Account for a Small
Proportion of U.S. Refinery Capacity**

Refinery Age

The age of a refinery is a second important factor that will affect the impact of any new air toxic regulations. Virtually no new refineries have been built since 1980. Retrofitting older refineries with new equipment required under air toxic regulations, especially in combination with other environmental regulations, may be more difficult and costly. In addition, owners of older, fully depreciated, refineries may find it more advantageous to close that facility than incur the relatively large capital costs required for compliance.

Refinery Location

Location will also affect the impact of the any new air toxic regulations on petroleum refineries. Figure IV-2 illustrates that most U.S. petroleum refining capacity is concentrated on

the Gulf Coast, in the Midwest, and on the West Coast. In major refining centers, such as the Gulf Coast, crude oil and petroleum product prices tend to be very competitive. Consequently, profit margins tend to be lower in these areas than in more remote locations. However, simple refineries often profit from being located near other more complex refineries because they can sell off unwanted heavy products, such as unfinished oil, to more complex refineries located nearby.

Figure IV-2

**U.S. Refining Capacity is Concentrated
in the Gulf Coast, Midwest and West Coast**

Source: DOE/EIA-0340(88)/1, "Petroleum Supply Annual 1988," May 1989, pp. 70-71.

In contrast, large, complex petroleum refineries located in areas far removed from major refinery centers tend to have higher profit margins. Petroleum product prices in these regions tend to be higher, reflecting the added cost of transporting products from the closest major

refining, or trading, area. However, simple refineries located in remote areas cannot easily sell off unwanted low value products such as residual fuel oil. In those instances where a simple refinery must ship residual fuel oil to a major refining center, the netback value to the refinery is low.^{16/}

CURRENT REFINERY PROFITABILITY

As shown in Figure IV-3, refiner profit margins have shown great variability over the past five years^{17/}. Refiner profit margins are strongly influenced by capacity utilization. In periods of low capacity utilization, refiner margins tend also to be low. But, as refiner capacity utilization increases, so do profit margins.

With the exception of brief periods at the end of 1985 and the spring of 1986, refiner margins were low or negative for much of the period from 1984 through 1987. In fact, refiner profit margins for Gulf Coast refineries averaged a negative \$0.60 per barrel in 1987.

^{16/} The netback value of a petroleum product is calculated as the delivered price at the destination point less the cost to transport it there.

^{17/} Refiner profitability for this analysis was measured as cash operating margins, which are calculated as product revenue less feedstock costs and less operating costs. This is a pre-tax measure of refiner profitability commonly used in the oil industry. For example, the Oil & Gas Journal, a daily trade magazine, publishes weekly estimates of refiner profit margins for different crude oils using this same measure.

Figure IV-3

U.S. Refinery Profit Margins Have Varied Greatly
Over the Past Five Years

Sources: April, 1984-January, 1989 - Oil and Gas Journal Data Base.
February, 1989-April, 1989 - Estimated from Spot Crude Oil and Petroleum Product Prices as reported By Platt's Oilgram Price Report.
May, 1989-December, 1989 - Estimated from New York Mercantile Exchange (NYMEX) Crude Oil and Petroleum Product Futures Prices.

* Refinery Profit margins shown are for a medium complexity refinery in the Gulf Coast region.

These low margins were due primarily to declining demand and resulting excess refining capacity throughout the early 1980s. However, petroleum product demand has increased in recent years in response to the collapse in crude oil prices and strong economic growth. In addition, many small refineries have been closed. Total U.S. refinery capacity has declined by over 2 million barrels per day since 1980, a decline of over 12 percent.^{18/} As petroleum product consumption has grown and total refinery capacity has declined, refinery capacity utilization and refiner profit margins have increased. Gulf Coast refiner profit margins average \$1.41 per barrel in 1988. Based on actual data through April 1989 and NYMEX futures prices for the remainder of the year, refiner margins are projected to average \$2.67 per barrel for 1989.

Refiner profit margins have been helped in particular by high capacity utilization on gasoline process units. Rising gasoline demand, the Exxon Valdez accident, and the loss of high quality North Sea crude oil production due to offshore platform explosions, have all led to high capacity utilization on gasoline process units.

Profit Margins for Simple and Complex Refineries

As noted above, complex refineries have the capability to make a large proportion of high valued petroleum products like gasoline and jet fuel and small amounts of low valued products like residual fuel oil. Simple refineries tend to make less gasoline and jet fuel and more residual fuel oil. Consequently, complex refineries tend to obtain higher product revenues than simple refineries. However, more complex refineries also have higher operating costs. Thus, in periods of excess capacity with depressed prices for high value products, it is possible for complex refineries to have lower profit margins than simple refineries.

^{18/} DOE/EIA-0384(88), "Annual Energy Review 1988," May 23, 1988, p. 129.

These points are illustrated in Figure IV-4 using estimated refinery profit margins for representative simple and complex refineries in the Gulf Coast.^{19/} The representative Gulf Coast complex refinery had an estimated profit margin of nearly \$0.50 per barrel, or 55 percent, higher than the simple refinery. However, in 1987, when overall refinery profit margins were depressed, both the complex and simple refineries had near zero profit margins.

Figure IV-4

**Complex Refineries Generally Have
Larger Profit Margins than Simple Refineries**

^{19/} Profit margins were calculated based on the assumption that both refineries use a high quality crude oil such as West Texas Intermediate. See the introduction for more information about the definition of refinery margins.

Regional Profit Margins^{20/}

Refineries located in the highly competitive Gulf Coast area have tended to have lower profit margins than refineries located in other regions of the U.S. (See Figure IV-5).

Figure IV-5

Gulf Coast Refineries Have Lower Profit Margins Than Other Refineries

On the East Coast and in the Midwest, higher product prices tend to more than offset the generally higher refiner acquisition costs that refineries must pay for crude oil.

West Coast refinery profit margins also tend to be higher than in the Gulf Coast. California crude oil price determination is a very complicated and contentious matter. Some

^{20/} The following discussion of regional differences in refinery profitability reflect long-term trends. Market supply and demand fluctuations can lead to temporary shifts in these long-term regional patterns.

have argued that West Coast oil companies have held crude oil prices artificially low. The U.S. Justice Department is currently conducting an anti-trust investigation of California crude oil pricing.^{21/} Others have argued that the prohibition on exports of Alaska crude oil plus in-state production has made California a surplus crude oil area, thereby depressing prices. For this analysis, crude oil on the West Coast is assumed to have the same price as crude oil sold in the Gulf Coast. Even with the conservative assumption of equivalent crude oil prices, West Coast refineries tend to have higher profit margins than Gulf Coast refineries, because product prices are higher on the West Coast.

FUTURE TRENDS IN U.S. REFINER PROFITABILITY

As noted above, U.S. refiners are currently enjoying a period of high profitability. Whether high profit margins will continue in the future will primarily depend on the interaction of supply and demand market forces. However, other non-market factors, such as government fiscal and environmental policy could also affect future refinery profitability. In particular, the future financial performance of the U.S. petroleum refining industry will depend on the following factors:

- The rate of growth in petroleum product demand
- Future refinery capacity additions
- Changes in tax policy
- Environmental regulations

After years of declining demand in the early and mid-1980's, petroleum product demand has increased in the past few years. Further increases in demand will tend to keep margins high. The U.S. Energy Information Administration (EIA) currently projects that free world petroleum

^{21/} Thomas W. Lippman, "Justice Department Probing Oil Firm Pricing," Washington Post, August 3, 1989.

product demand will increase by 1.8 percent in 1990.^{22/} EIA estimates that demand will continue to grow by an average annual rate of 1 percent from 1990 to 1995, before slowing to only 0.3 percent per year through 2000. Free world petroleum product demand is projected to be 5 million barrels per day, or 10 percent, higher in 2000 than it was in 1988. A recent CONOCO publication projects petroleum demand growth at 1.5 percent annually over this period.^{23/}

Whether this increase in petroleum product demand will be sufficient to maintain refinery profit margins will depend in part on how much refinery processing capacity is added in the coming years. Relatively little crude distillation capacity has been added in the 1980s. Refinery investment for the most part has been focused on downstream conversion and upgrading capacity. However, the recent high profit margins could encourage further refinery investment. Large additions to refinery capacity would tend to lower average utilization rates and lower refiner profit margins. In the long run, sufficient refinery capacity should be added to meet demand and reduce profit margins to the point where refineries are making a rate of return comparable to alternative investment opportunities.

Changes in U.S. tax policy could also affect refiner profitability. For example, a gasoline tax would tend to lower demand, depress refinery capacity utilization, and lower refiner profits. A crude oil import tariff would tend to raise refiner crude oil acquisition costs that could either reduce profits directly if the added costs were not passed on to consumers, or reduce demand and indirectly affect refiner profitability.

Environmental regulations that specify petroleum product fuel content, such as the recently promulgated gasoline volatility requirements, can increase profits for refineries well equipped to make products that comply with the new guidelines. Since both domestic and imported products must meet the same product specifications, refineries should be able to recover the incremental

^{22/} U.S. DOE/EIA-0484(89), "International Energy Outlook 1989," March 1989.

^{23/} CONOCO, "World Energy Outlook Through 2000," 1989.

costs incurred to make compliance products. The federal and northeastern states gasoline volatility regulations along with the federal diesel sulfur content regulations, should tend to marginally improve refiner profitability.^{24/}

In contrast, stationary source regulations, such as hazardous waste site regulations and EPA's planned revisions to refinery effluent guidelines, as well as any new air toxic regulations that result from the proposed legislation, will tend to lower refiner profitability. Foreign refineries will not have to incur the compliance costs associated with these stationary source regulations. Thus, the cost of foreign imports will not be affected and domestic refineries may find it difficult to recover the costs of complying with stationary source regulations.

While all these factors will clearly influence future U.S. refinery profitability, they also add to the uncertainty associated with any projections of refiner margins. Because of this uncertainty, two alternative estimates of future refiner profitability are used for the refinery impact analysis reported below. One case uses the estimated representative refiner profit margins for 1988 to examine impacts of the air toxic regulations in high profitability conditions. The second case uses the estimated representative refinery profit margins for 1987 to examine impacts of potential air toxic regulations in low profitability conditions.

PROJECTED REFINERY IMPACTS

This section of the report presents an analysis of the potential impact of the proposed air toxic regulations on the petroleum refinery industry. Estimates of refinery impact are presented for two regulatory scenarios. In Scenario I, the EPA is assumed to interpret Maximum Achievable Control Technology to mean more frequent and stringent inspection and maintenance programs and other relatively low cost (compared to Scenario II) control strategies. In Scenario

^{24/} The impact of fuel specification versus stationary source regulations is also discussed in the introduction to this report. For a more detailed discussion, see: ICF Resources, "The Effect of Air Pollution Regulations on the U.S. Refining Industry," June 1989.

II, leakless equipment and other higher cost control strategies are assumed to be required as well. For each of these scenarios, estimates of the impact of air toxic compliance costs on representative simple and complex refineries are reported. Refinery impact estimates for low profitability and high profitability cases are also examined.

Table IV-1 and Table IV-2 present estimates of the potential impact of hypothetical new air toxic regulations on refinery profit margins by region and complexity for both regulatory scenarios. The discussion of current and future profitability trends presented above illustrated that Gulf Coast refineries tend to have lower profit margins than refineries located in other regions. Consequently, Gulf Coast refineries may be the most at risk from air toxic regulations. In the analysis summarized below, therefore, estimates of refinery impact are focused on the Gulf Coast. Impacts for refineries in other regions will likely be smaller. However, small, simple refineries located in isolated regions could also be more adversely affected.

Scenario I

As presented in Chapter III, compliance costs in Scenario I are estimated to be \$0.07 per barrel for both a simple and complex refinery. While these costs may appear to be small in comparison to current crude oil prices of \$18 to \$20 per barrel, they could have a significant impact on refinery profitability. As shown in Figure IV-6, in the high profitability case in which market conditions similar to those in 1988 are assumed, compliance costs of this order of magnitude would represent 6 percent of a complex refineries cash operating margins and 9 percent of a simple refineries margins. In a low profitability case with market conditions similar to those in 1987, compliance costs in Scenario I would further increase Gulf Coast refinery losses. (See Figure IV-7).

Table IV-1

Representative Simple Refinery
Potential Impact of New Hazardous Air Toxic Regulations
(1989 Dollars per Barrel)

	SCENARIO I		SCENARIO II		COMBINED SCENARIOS	
	LOW PROFITABILITY	HIGH PROFITABILITY	LOW PROFITABILITY	HIGH PROFITABILITY	LOW PROFITABILITY	HIGH PROFITABILITY
EAST COAST						
REFINER MARGIN	\$1.09	\$1.80	\$1.09	\$1.80	\$1.09	\$1.80
COMPLIANCE COSTS	\$0.07	\$0.07	\$0.43	\$0.43	\$0.50	\$0.50
ADJUSTED REFINER MARGIN	\$1.02	\$1.73	\$0.66	\$1.37	\$0.59	\$1.30
MIDWEST						
REFINER MARGIN	\$0.48	\$2.11	\$0.48	\$2.11	\$0.48	\$2.11
COMPLIANCE COSTS	\$0.07	\$0.07	\$0.43	\$0.43	\$0.50	\$0.50
ADJUSTED REFINER MARGIN	\$0.41	\$2.04	\$0.05	\$1.68	(\$0.02)	\$1.61
GULF COAST						
REFINER MARGIN	(\$0.75)	(\$0.25)	(\$0.75)	(\$0.25)	(\$0.75)	(\$0.25)
COMPLIANCE COSTS	\$0.07	\$0.07	\$0.43	\$0.43	\$0.50	\$0.50
ADJUSTED REFINER MARGIN	(\$0.82)	(\$0.32)	(\$1.18)	(\$0.68)	(\$1.25)	(\$0.75)
WEST NORTH CENTRAL						
REFINER MARGIN	\$2.33	\$3.45	\$2.33	\$3.45	\$2.33	\$3.45
COMPLIANCE COSTS	\$0.07	\$0.07	\$0.43	\$0.43	\$0.50	\$0.50
ADJUSTED REFINER MARGIN	\$2.26	\$3.38	\$1.90	\$3.02	\$1.83	\$2.95
WEST COAST						
REFINER MARGIN	(\$0.63)	\$0.80	(\$0.63)	\$0.80	(\$0.63)	\$0.80
COMPLIANCE COSTS	\$0.07	\$0.07	\$0.43	\$0.43	\$0.50	\$0.50
ADJUSTED REFINER MARGIN	(\$0.70)	\$0.73	(\$1.06)	\$0.37	(\$1.13)	\$0.30

Table IV-2

Representative Complex Refinery
Potential Impact of New Hazardous Air Toxic Regulations
(1989 Dollars per Barrel)

	SCENARIO I		SCENARIO II		COMBINED SCENARIOS	
	LOW PROFITABILITY	HIGH PROFITABILITY	LOW PROFITABILITY	HIGH PROFITABILITY	LOW PROFITABILITY	HIGH PROFITABILITY
EAST COAST						
REFINER MARGIN	\$2.24	\$4.19	\$2.24	\$4.19	\$2.24	\$4.19
COMPLIANCE COSTS	\$0.08	\$0.08	\$0.33	\$0.33	\$0.41	\$0.41
ADJUSTED REFINER MARGIN	\$2.16	\$4.11	\$1.91	\$3.86	\$1.83	\$3.78
MIDWEST						
REFINER MARGIN	\$1.53	\$3.82	\$1.53	\$3.82	\$1.53	\$3.82
COMPLIANCE COSTS	\$0.08	\$0.08	\$0.33	\$0.33	\$0.41	\$0.41
ADJUSTED REFINER MARGIN	\$1.45	\$3.74	\$1.20	\$3.49	\$1.12	\$3.41
GULF COAST						
REFINER MARGIN	(\$0.10)	\$1.41	(\$0.10)	\$1.41	(\$0.10)	\$1.41
COMPLIANCE COSTS	\$0.08	\$0.08	\$0.33	\$0.33	\$0.41	\$0.41
ADJUSTED REFINER MARGIN	(\$0.18)	\$1.33	(\$0.43)	\$1.08	(\$0.51)	\$1.00
WEST NORTH CENTRAL						
REFINER MARGIN	\$3.11	\$4.74	\$3.11	\$4.74	\$3.11	\$4.74
COMPLIANCE COSTS	\$0.08	\$0.08	\$0.33	\$0.33	\$0.41	\$0.41
ADJUSTED REFINER MARGIN	\$3.03	\$4.66	\$2.78	\$4.41	\$2.70	\$4.33
WEST COAST						
REFINER MARGIN	\$1.88	\$4.17	\$1.88	\$4.17	\$1.88	\$4.17
COMPLIANCE COSTS	\$0.08	\$0.08	\$0.33	\$0.33	\$0.41	\$0.41
ADJUSTED REFINER MARGIN	\$1.80	\$4.09	\$1.55	\$3.84	\$1.47	\$3.76

Scenario II

In Scenario II, refiner compliance costs were estimated to range from \$0.30 to \$0.40 per barrel for a complex refinery and from \$0.40 to \$0.50 per barrel for a simple refinery. Compliance costs of this order of magnitude would represent nearly 25 to 30 percent of a Gulf Coast complex refinery's profit margin in a high profitability case. A simple Gulf Coast refinery, with lower profit margins, could lose as much as 50 to 60 percent of its profits in a high profitability case. (See Figure IV-8). Profit margins for refineries in other regions would suffer smaller, but still substantial, percentage declines.

As shown in Figure IV-9, in a low profitability case, compliance costs in Scenario II could lead to large losses for Gulf Coast refineries. Profit margins for refineries in other regions would also be adversely affected.

CONCLUSIONS

The analysis presented in this report has shown that the petroleum refinery industry could be adversely affected by new air toxic regulations. EPA's interpretation of Maximum Achievable Control Technology will be a critical determinant of how large an impact air toxic regulations will have. If MACT is interpreted to mean improved inspection and maintenance and other relatively low cost process or operational modifications, refiner impact will be reduced. However, if MACT is interpreted to require the installation of leakless valves, flanges, pumps, and compressors, and other high cost technologies, the refinery profitability could be substantially reduced.

The ultimate impact of any new air toxic regulations on the petroleum refining industry will also depend on the relative health of the industry at the time the regulations are promulgated. While petroleum refinery profit margins are presently high, they have

Figure IV-6

Scenario I
High Profitability Case
Air Toxic Compliance Costs Could Have A Significant Impact of Refinery Profitability
(Dollars per Barrel)

Figure IV-7

Scenario I
Low Profitability Case
Air Toxic Compliance Costs Could Further Increase Refinery Losses
(Dollars per Barrel)

Figure IV-8

Scenario II
High Profitability Case
Air Toxic Compliance Costs Could Have A Significant Impact of Refinery Profitability
(Dollars per Barrel)

Figure IV-9

Scenario II
Low Profitability Case
Air Toxic Compliance Costs Could Further Increase Refinery Losses
(Dollars per Barrel)

shown great variability over the last decade. If air toxic regulations are imposed during a period of low profit margins, and particularly if MACT is interpreted aggressively, simple as well as complex refineries may find it uneconomic to continue operations.

The proposed air toxic legislation is only one of many environmental initiatives confronting petroleum refineries. Other components of the President's Clean Air Plan, in particular the alternative fuels program which calls for up to one million alternative fuel cars per year, could adversely affect refinery economics by reducing the demand for gasoline. In addition, petroleum refineries must also incur costs to comply with other new or modified environmental regulations such as EPA's planned revisions to refinery effluent guidelines. Other regulations, as well as controls on waste water and solid waste, are also in effect. The compliance costs of all these regulations taken together could have a substantial adverse impact on refinery profitability.

APPENDIX A

Detailed Compliance Cost Estimates For Representative Refinery Types

TABLE A-1

SIMPLE REFINERY
REFINERY COMPLIANCE COSTS
SCENARIO I

COMPONENT	CAPITAL COST (M \$)	USEFUL LIFE (YEARS)	ANNUALIZED CAPITAL COST (M \$)	O&M COST (M \$)	TOTAL ANNUAL COST (M \$)	COST PER BARREL (\$/BBL)
MARINE VAPOR RECOVERY	\$1,200	10	\$178	\$77	\$254	\$0.0232
CONE ROOF TANKS	\$2,160	15	\$258	\$46	\$304	\$0.0278
I&M, V/F/P/C	NA	NA	NA	\$142	\$142	\$0.0130
FLARES	\$75	10	\$11	\$3	\$14	\$0.0013
SEWER SYSTEM DRAINS	\$53	20	\$6	\$1	\$7	\$0.0006
SAFETY VALVES RUPTURE DISC	\$25	10	\$4	\$1	\$5	\$0.0004
COMBUSTION ENGINES	\$10	5	\$2	\$1	\$3	\$0.0003
TOTAL	\$3,524		\$459	\$271	\$730	\$0.0666

TABLE A-2

COMPLEX REFINERY
REFINERY COMPLIANCE COSTS
SCENARIO I

COMPONENT	CAPITAL COST (M \$)	USEFUL LIFE (YEARS)	ANNUALIZED CAPITAL COST (M \$)	O&M COST (M \$)	TOTAL ANNUAL COST (M \$)	COST PER BARREL (\$/BBL)
MARINE VAPOR RECOVERY	\$7,500	10	\$1,110	\$479	\$1,589	\$0.0435
CONE ROOF TANKS	\$3,360	15	\$402	\$72	\$473	\$0.0130
I&M, V/F/P/C	NA	NA	NA	\$638	\$638	\$0.0175
FLARES	\$225	10	\$33	\$10	\$43	\$0.0012
SEWER SYSTEM DRAINS	\$160	20	\$17	\$3	\$20	\$0.0006
SAFETY VALVES RUPTURE DISC	\$76	10	\$11	\$3	\$14	\$0.0004
COMBUSTION ENGINES	\$60	5	\$14	\$4	\$18	\$0.0005
TOTAL	\$11,381		\$1,587	\$1,209	\$2,796	\$0.0766

TABLE A-3

SIMPLE REFINERY
REFINERY COMPLIANCE COSTS
SCENARIO II

COMPONENT	CAPITAL COST (M \$)	USEFUL LIFE (YEARS)	ANNUALIZED CAPITAL COST (M \$)	O&M COST (M \$)	TOTAL ANNUAL COST (M \$)	COST PER BARREL (\$/BBL)
LEAKLESS VALVES	\$2,848	10	\$421	\$0	\$421	\$0.0385
FLANGES	\$4,315	8	\$735	\$0	\$735	\$0.0671
EXT. FLOATING ROOF TANKS	\$6,400	15	\$765	\$273	\$1,038	\$0.0948
INT. FLOATING ROOF TANKS	\$4,000	10	\$592	\$256	\$847	\$0.0774
PUMPS	\$1,728	10	\$256	\$110	\$366	\$0.0334
CENTRAL VAPOR RECOVERY	\$2,500	15	\$299	\$107	\$405	\$0.0370
COMPRESSORS	\$480	15	\$57	\$10	\$68	\$0.0062
GAS RECOVERY UPGRADE	\$2,000	10	\$296	\$128	\$424	\$0.0387
FLARES	\$1,500	15	\$179	\$64	\$243	\$0.0222
MAIN SEPARATOR BATTERY	\$750	15	\$90	\$32	\$122	\$0.0111
INTERNAL COMBUSTION ENGINES	\$80	5	\$19	\$5	\$24	\$0.0022
TRUCK LOADING	\$200	10	\$30	\$13	\$42	\$0.0039
TOTAL	\$26,801		\$3,739	\$997	\$4,736	\$0.4325

TABLE A-4

COMPLEX REFINERY
REFINERY COMPLIANCE COSTS
SCENARIO II

COMPONENT	CAPITAL COST	USEFUL LIFE (YEARS)	ANNUALIZED CAPITAL COST	O&M COST (M \$)	TOTAL ANNUAL COST (M \$)	COST PER BARREL
LEAKLESS VALVES	\$12,762	10	\$1,888	\$0	\$1,888	\$0.0517
FLANGES	\$19,336	8	\$3,295	\$0	\$3,295	\$0.0903
EXT. FLOATING ROOF TANKS	\$10,000	15	\$1,195	\$426	\$1,621	\$0.0444
INT. FLOATING ROOF TANKS	\$6,250	10	\$925	\$399	\$1,324	\$0.0363
PUMPS	\$7,236	10	\$1,071	\$462	\$1,533	\$0.0420
CENTRAL VAPOR RECOVERY	\$5,000	15	\$598	\$213	\$811	\$0.0222
COMPRESSORS	\$3,840	15	\$459	\$82	\$541	\$0.0148
GAS RECOVERY UPGRADE	\$4,000	10	\$592	\$256	\$847	\$0.0232
FLARES	\$1,500	15	\$179	\$64	\$243	\$0.0067
MAIN SEPARATOR BATTERY	\$750	15	\$90	\$32	\$122	\$0.0033
INTERNAL COMBUSTION ENGINES	\$240	5	\$58	\$15	\$73	\$0.0020
TRUCK LOADING	\$200	10	\$30	\$13	\$42	\$0.0012
TOTAL	\$71,114		\$10,378	\$1,962	\$12,340	\$0.3381

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