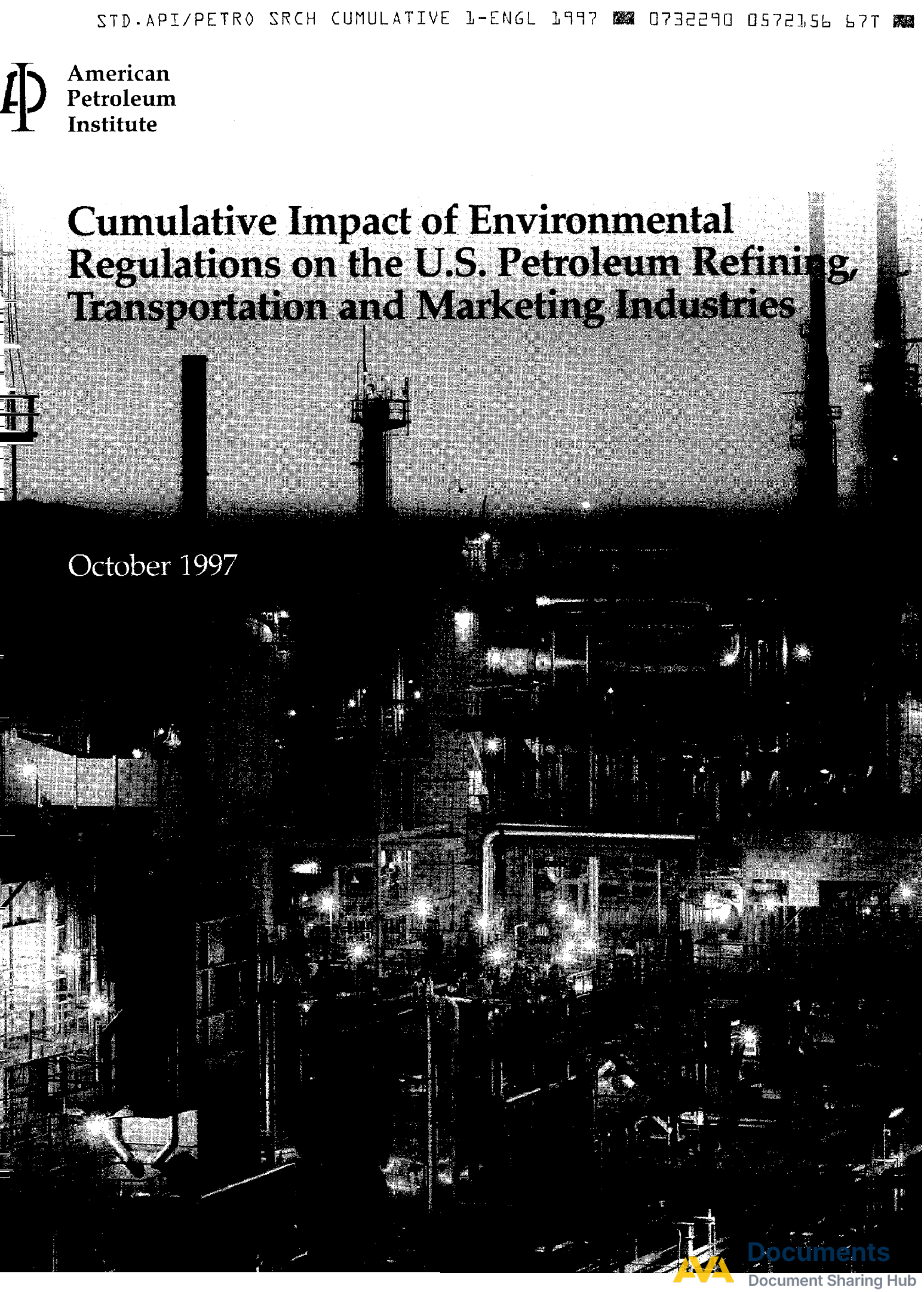
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Cumulative Impact of Environmental Regulations on the U.S. Petroleum Refining, Transportation and Marketing Industries

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Developed for:
API Committee on Refinery Environmental Control

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Cumulative Impact of Environmental Regulations on the U.S. Petroleum Refining, Transportation and Marketing Industries

EXECUTIVE SUMMARY

The petroleum industry is a vital component of the United States economy. Over forty percent of U.S. energy consumed is processed and transported by this industry. It provides jobs for hundreds of thousands of people and contributes over $19 billion in "value added" to the domestic economy.

New environmental regulations are under consideration that could affect the petroleum industry's contributions to the economy. Some of the regulations being considered may be more stringent than is warranted by sound science or necessary to protect human health or the environment. Some of them have been the focus of considerable public debate. These regulations, taken in combination with other pending requirements, will have serious affects on the petroleum industry, the economy, and the nation — reducing investment in capacity and new technologies, making domestic refiners less competitive in the global marketplace, increasing imports of refined products by up to 500,000 barrels per day, increasing consumer prices for products such as gasoline and heating oil, and reducing industry employment.

Petroleum industry expenditures in the U.S. to comply with existing environmental regulations totaled $9.6 billion in 1995. Refining accounts for 59% of this total — over $5.7 billion. Refineries have to comply both with controls on the refinery itself and requirements to produce cleaner fuels (reformulated gasoline and lower sulfur diesel fuel). A second phase of reformulated fuels requirements takes effect in 2000, which will lead to further plant modifications for compliance. The transportation and marketing sectors account for another 23% of total environmental compliance expenditures. The remainder of total costs are expenditures by the exploration and production sector, corporate expenditures, and research and development costs.

Several requirements have been finalized over the past few years that will add to these compliance expenditures. Some of the major new requirements provided several years for compliance. Refiners will be making the necessary adjustments to comply with maximum achievable control technology (MACT) requirements for many emission sources in the refinery through 1998 and beyond. Companies have begun performing the analyses required by the risk management program rule and most have submitted applications for obtaining their operating permits under Title V of the Clean Air Act. Companies in the transportation and marketing sector are still working to make the changes required by MACT standards for marine terminals and gasoline distribution and requirements for underground storage tanks. These regulations will push up the level of current environmental expenditures by the industry.

The addition of compliance requirements does not stop there. Several new requirements are under consideration that will add substantially to compliance costs for the industry. Although the list of possible future requirements is long (see Appendices C and D), this analysis focused on the following:

Refining

- Listing of certain refinery waste streams as hazardous
- Installation of devices to assure compliance with existing air requirements
- MACT controls for process vents not covered by the earlier regulation
- MACT controls for combustion sources, including heaters and boilers
- State implementation of guidance for limiting short-term SO_2 exposures
- Revision of federal air quality standards for ozone
- Revision of federal air quality standards for particulate matter
- Installation of release prevention barriers on above ground storage tanks.

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Transportation

- Additional spill prevention measures on liquids pipelines
- Installation of release prevention barriers on above ground storage tanks.

Marketing

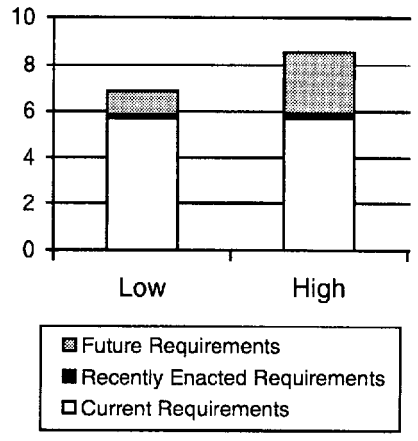
- Reporting under Toxics Release Inventory for bulk terminals
- Installation of release prevention barriers on above ground storage tanks.

Because many of these initiatives have not yet reached the proposed rule stage, it was necessary to make assumptions about the likely requirements or a range of possible requirements. In all cases, this analysis has tried to avoid a "worst case" characterization of the future. This means that the costs estimated are a realistic assessment of future costs of compliance, and that costs could be higher if any of these estimated requirements is more stringent than assumed herein. Costs were estimated by determining the changes that would likely be required for compliance, then applying an engineering-based costing approach to determine the costs of making the necessary modifications.

Taken cumulatively, these new regulations could impose an *additional* $4 billion to $7 billion (annualized) in costs on the petroleum industry. In the near term, the industry could face considerable constraints on capital availability, as it attempts to make available the $9 billion to $24 billion in up front investment that would be required for compliance.

For the refining industry, total cumulative compliance costs could exceed $8.5 billion annually if these new environmental regulations are implemented as anticipated (see figure). This does not include the expenditures that will be necessary to comply with the second phase of reformulated fuels requirements, or the possible costs attributable to other future requirements not covered by this analysis. The eight new requirements considered in this analysis could add from $1 billion to $2.6 billion in costs on an annualized basis. These are substantial costs that will affect the economics of this important sector of the U.S. economy.

Potential Environmental Compliance Expenditures of Refining Industry Billion 1995 Dollars



The additional compliance costs will have both direct effects (increasing the cost of refining and reducing margins) and indirect effects. Since environmental investments compete with discretionary technology upgrades and capacity additions, the funds available for discretionary investments will be reduced. This means that remaining investments will need to meet a higher hurdle rate to receive funding. This result, combined with the lower margins that will result from the added compliance costs, will eliminate much needed investment in new or upgraded capacity beyond debottlenecking. This will leave domestic refiners stretched to meet domestic demand, raising import dependency by as much as 500,000 barrels per day. The high level of compliance costs may lead less profitable refineries to shut down, resulting in job loss for their workers, suppliers and contractors. Governments at all levels would also lose tax revenues. Reduced domestic investment in upgrading technologies will affect crude oil and refined product prices. Lighter crude oils and lighter products (such as gasoline and heating oil) will begin to demand a premium, while prices will fall for heavier, higher sulfur crude oils. This will have repercussions throughout world crude and product markets, as well as higher prices for domestic consumers.

Environmental regulations have the potential for serious impacts on the petroleum industry, and by extension, the domestic economy. If these regulations are truly necessary to protect human health and

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the environment, then few would argue that those tradeoffs should not be made. But when regulations are more stringent than necessary, the economic impacts are unjustified. If some of the regulations analyzed are not truly essential to environmental and health protection, then our domestic petroleum industry is being disadvantaged unnecessarily. The types of impacts examined in this analysis — growing import dependency, rising consumer prices, job loss — are not easily recovered if it is later determined that the regulations were more stringent than necessary. If investments in the domestic petroleum industry are delayed or eliminated, U.S. refiners will be at a disadvantage in world markets. U.S. consumers will ultimately pay the price for these decisions.

The question facing the nation is how to balance costs and benefits so that we are doing what is necessary to protect human health and the environment, without overly burdening companies with costly requirements that do not produce commensurate benefits. This can be accomplished by changing our regulatory development process to include the following elements:

- Use of sound science in establishing requirements
- Substitution of risk-based for "list based" and "technology-based" regulatory approaches
- Consideration of alternatives to command and control regulations
- Use of cost-benefit analysis in developing standards.

Revamping our regulatory development structure is important. As science and technology have improved, the nation needs to reconsider regulatory frameworks developed decades ago before environmental awareness was heightened. Regulations need to be developed with today's realities in mind. If we do not take action to make regulations more flexible and risk based, U.S. companies will become less competitive in the global marketplace and costs will be reflected in higher consumer prices. These are trade-offs that must be evaluated if the petroleum industry is to continue its vital contributions to the nation.

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I. INTRODUCTION

As large, stationary plants, refineries are an obvious target for environmental regulations designed to control the potential for impacts on air, water, and land. Consequently, these facilities are highly regulated, facing over 120 federal regulations that tightly control their handling of wastes, effluents, and air emissions. Nonetheless, whenever further reductions are desired, refineries are often near the top of the list of industries targeted, at least in part because of their visibility. In addition, refining has the distinction of being one of the only industries where environmental regulations create double requirements — stationary source restrictions on emissions from the plant itself and specifications for the products produced. The latter, including reformulated gasoline and potential further restrictions on sulfur content in both gasoline and diesel fuel, require expensive modifications and emission controls on the plant itself, which are in addition to the types of environmental compliance requirements faced in other industries.

Bulk storage terminals, which serve as intermediate points in the distribution chain to move fuels from the refinery to the customer, are covered by many of the same rules as refineries, although the activities that can potentially produce effluents, emissions, or waste are fewer and smaller than at refineries. Pipelines transport crude oil to refineries and refined products to storage terminals. Pipeline activities are mostly covered by Department of Transportation regulations, although Environmental Protection Agency (EPA) rules play a growing role at these facilities. Since the costs associated with distribution are part of the final cost of refined products to the consumer, increasing costs of environmental compliance can erode operating margins, and ultimately lead to increased costs passed through to the consumer.

The marketing sector consists of numerous local distribution sites, including the corner gasoline station, which is the most visible representation of the petroleum industry to the general public. While they may carry the brand of a major oil company, most are owned or operated by small independent dealers or individuals. Incremental costs of environmental compliance can pose a substantial burden on these small operators. If market conditions will bear it, these costs may be passed through to the consumer. If costs cannot be passed along, the economic viability of these operations can be threatened.

The purpose of this study is to examine the current level of environmental compliance costs for the petroleum refining, distribution, and marketing industries and to estimate the cost and impact of compliance with regulations that have recently been passed (for which compliance is currently underway) and regulations that are currently under consideration by Federal agencies. These industries also face incremental compliance costs at the state and local level; costs that have not been considered in this analysis, could be substantial, and would be incremental to those discussed herein.

The remainder of this report is organized into five major sections and seven appendices as described briefly below:

- Industry situation — this section describes the current operating environment and economic conditions within the refining, transportation, and marketing sectors of the petroleum industry
- Current environmental requirements — this section discusses the current level of environmental compliance expenditures by the petroleum industry along with the number and complexity of current environmental requirements facing the industry
- Future requirements on refining industry — this section describes recently promulgated requirements with which the industry is still working to comply, along with eight major new regulations that are expected to result in new requirements for the refining industry. The costs of each of these regulations are discussed, and the economic impact of the incremental costs on the refining industry is described.
- Future requirements on transportation and marketing industry — this section describes several recent requirements facing the industry and discusses three new requirements that are expected to create added requirements for bulk storage terminals and liquids pipelines. The cost of these new requirements are also estimated.

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II. INDUSTRY SITUATION

Nearly forty percent of the energy consumed in the U.S. consists of petroleum products, most of which are refined in the nation's refineries and all of which move through the distribution and marketing network. Nearly 18 million barrels of refined petroleum products are used in the U.S. every day. The efficient functioning of petroleum refining, distribution, and marketing systems are essential to the health of the domestic economy.

Not only does the petroleum industry provide the fuel the nation needs, it provides jobs for numerous workers and contributes substantial value added to the national economy. Refineries employ nearly 100,000 individuals; most of these are highly skilled, technical jobs. Bulk storage terminals and pipelines account for over 80,000 jobs, while nearly 650,000 people are employed by gasoline service stations. The refining industry was responsible for $19.1 billion in "value added" in 1992, according to the U.S. Census Bureau. This figure represents the value of this industry to the nation.

The refining industry has undergone radical changes in the past fifteen years. Competitive pressures have increased, and feedstock prices have gone on a rollercoaster ride. Entitlement programs and small refiner preference programs have ended. Environmental protection requirements have expanded substantially. These changes have led to the closure of over 140 refineries and loss of more than 55,000 jobs since 1980.

The refining industry is diverse, with plants ranging in size from a 1,300 barrels per day (b/d) specialty plant to a capacity of 433,000 b/d, with an average capacity of just over 93,000 b/d. Many of the smaller refineries specialize in particular products (e.g., asphalt, lube oils) or are geared to serve a particular, somewhat isolated market (e.g., the Salt Lake valley). Most of the largest capacity refineries are located along the coast, processing imported and domestic crude oil for use throughout the U.S. Each refinery has a unique set of upgrading equipment (hydrotreaters, hydrocrackers, reforming units) that is dictated by the type of feedstock typically processed (quality and gravity of the crude oil) and the type of refined products demanded in the markets served.

Refineries take raw materials, such as crude oil, natural gas liquids, and process gas oil, and transform them into a wide range of products that are used throughout the economy. Consumers are demanding more of the lighter end products (gasoline, diesel fuel) and far less of the heavier products such as residual fuel oil. The crude oil processed is starting to become heavier and higher in sulfur. Both trends necessitate additional upgrading, leading to larger, more complex refineries with a wider range of process units. Environmental regulations defining the composition of products lead to additional process modifications.

U.S. refiners are not isolated from international pressures. The price of crude feedstocks is set in international markets, and can fluctuate widely, affecting the economics of operations. Products from domestic refineries must compete with imported products, many of which were produced in countries with less stringent environmental requirements. Environmental regulations in the U.S. are not only more stringent and costly than in many other areas of the world — they focus more on "command and control" approaches to achieve environmental protection, which can limit flexibility to respond to competitive pressures.

Cash operating margins at refineries are variable, but generally not favorable. For example, in 1995, Gulf Coast operating margins ranged from a negative $3.04/bbl in the first quarter to a positive $1.19/bbl in the second quarter. On average for the year, the cash margin was $0.34/bbl.[1] This is before corporate overhead, depreciation, research and development expenditures, or return on investment. If the price of feedstock rises (as it did in 1996) and the higher costs are reflected in the price of gasoline, consumers are quick to accuse companies of "windfall profits" at their expense. Given the price sensitivity

[1] Margins calculated by Wright Killen & Co., as quoted in *Oil & Gas Journal*.

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of consumers, it is clear that increased operating costs (due to increased environmental regulations) *cannot easily be recouped, eroding* already small margins.

Once products have been refined, they move out of the refinery and into the distribution and marketing system. With refineries often clustered near ports (to receive imports) or near other sources of supply, an efficient and effective network has been developed to move refined products to consumers. Moreover, with a wide range of products to be moved, it would be infeasible to build a separate pipeline or distribution system for each. So the network has been developed to be flexible, allowing multiple products to be "batched" through the system, with intermediate storage tanks for different products along the network.

The advent of reformulated gasoline (RFG) complicated this network. Since not all areas of the country needed or wanted the new formulation, new transportation patterns along the network had to be established to assure that adequate supplies were available when needed in the appropriate markets. Without these changes, shortages could have developed — not because there was not enough gasoline, but because it could not be moved to where it was being demanded. Before the advent of RFG, gasoline was fungible; batches of gasoline from different refineries could be combined. With RFG, the different formulations necessitate keeping the gasoline from each refinery separate in non-attainment areas. Some terminals even find it necessary to drain and clean tanks between shipments.

While not glamorous, or even obvious to most people, the distribution and marketing sector of the petroleum industry plays a crucial role in keeping our economy moving. A failure of operations in this sector could potentially disrupt millions of lives and businesses. Despite its importance, distribution and marketing operations operate on very thin margins. Market sensitivity limits how much they can charge to transport products to market.

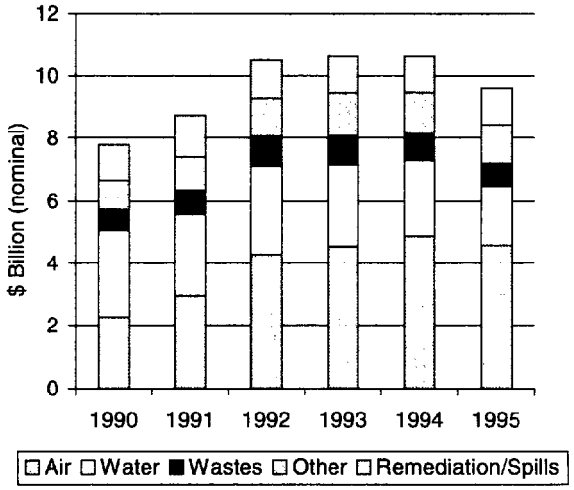
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III. CURRENT ENVIRONMENTAL REQUIREMENTS

Environmental compliance expenditures by the petroleum industry (in aggregate) are equal to about $100 for every household in the United States. In 1995, that totaled $9.6 billion, more than the annual budget of the Environmental Protection Agency, and about half of the profits of the top 200 oil and gas companies as reported in the *Oil & Gas Journal*.[2]

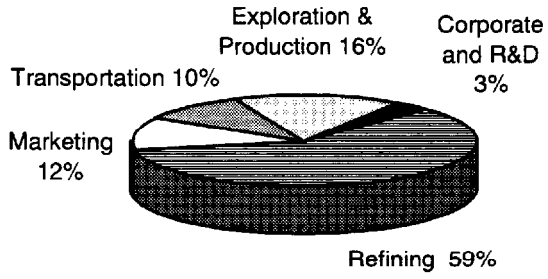
Figure 1
Estimated U.S. Petroleum Environmental Compliance Expenditures by Medium



Compliance with the Clean Air Act Amendments of 1990 has led to a major increase in air-related expenditures. In 1990, the petroleum industry spent $2.3 billion on air-related requirements. As shown in Figure 1, by 1995, this amount totaled nearly $4.6 billion. Equipping refineries to make reformulated fuels accounts for much of this increase. Air-related compliance costs now account for nearly half of total environmental spending by the petroleum industry.

Refining accounts for 59% of total environmental expenditures by the petroleum industry, or nearly $5.7 billion annually (Figure 2). Transportation accounts for 10% of total expenditures (nearly $1 billion), while the marketing sector adds 12% ($1.1 billion). The remainder of total environmental expenditures are in the exploration and production sector, corporate programs, and research and development expenditures related to environmental improvement.

Figure 2
Environmental Expenditures by Industry Sector 1995



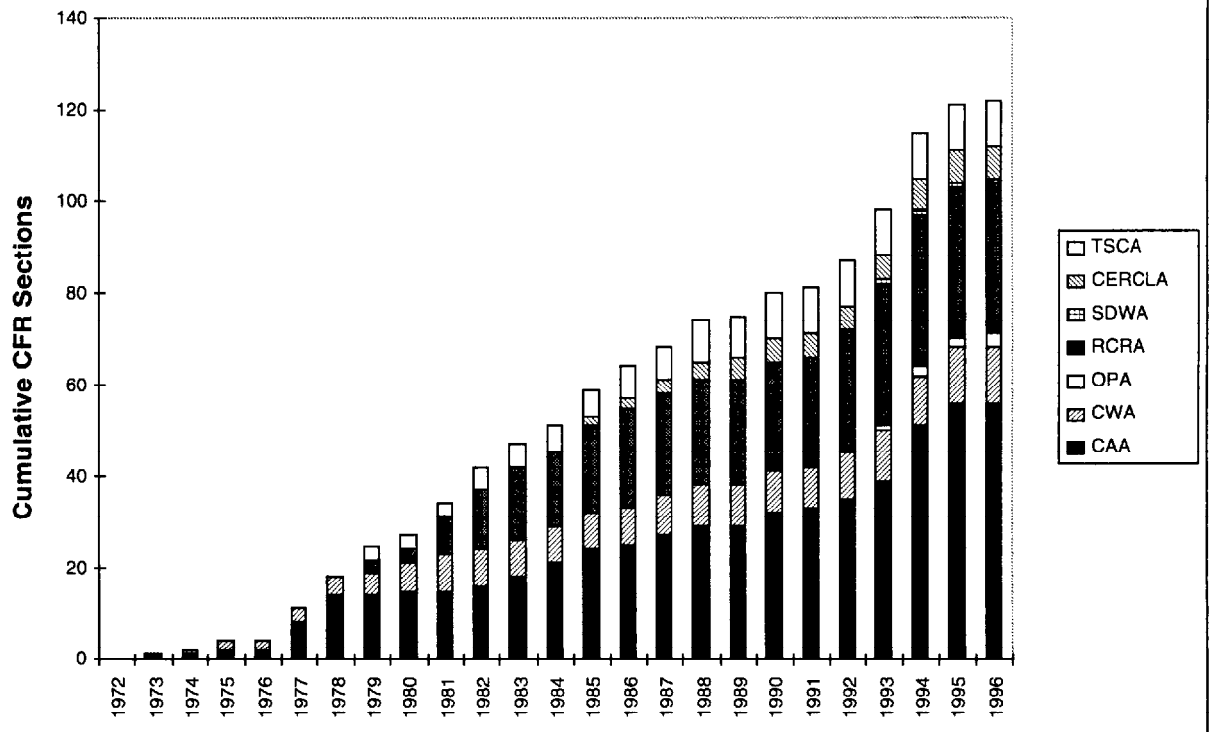
An individual refinery's share of these costs will vary widely, depending on what controls may be in place and the particular units and configuration of units at its location. A very rough estimate, however, could be based on refinery capacity. Using that approach, a hypothetical 100,000 b/d refinery could be assumed to expend $37.1 million annually on environmental compliance.

U.S. refineries currently must respond to overlapping and sometimes conflicting requirements from multiple agencies and jurisdictions, which increases costs without increasing benefits to the environment. Compliance with federal requirements alone can be confusing. In 1996, over 120 parts and subparts of the Code of Federal Regulations (CFR) include requirements with which refiners must comply. As shown in the figure on the following page, this number has grown rapidly and steadily since 1972, with applicable requirements under the Clean Air Act; Clean Water Act; Oil Pollution Act; Resource Conservation and Recovery Act; Safe Drinking Water Act; Comprehensive Environmental Response, Compensation, and

[2] American Petroleum Institute, *Petroleum Industry Environmental Performance, Fifth Annual Report*, May 1997.

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Figure 3
Cumulative CFR Sections With Environmental Regulations Covering the Refining Industry



Liability Act; and the Toxic Substances Control Act. Appendix A lists the numerous federal environmental regulations with which refineries currently must comply, and Appendix B provides a similar compilation for bulk storage terminals and pipelines. State and local requirements are in addition to those listed.

Determining appropriate actions that will comply with all existing requirements is a complex task. The environmental requirements refiners face include both fuel specifications and stationary source controls on the plant itself. Plant requirements can include specific end-of-pipe controls (e.g., permitted wastewater discharges), general industry requirements (e.g., control of fugitive emissions, land disposal restrictions on certain wastes), and overlap from other industries (e.g., chemical controls for MTBE additives). Facilities also have to be concerned about applicable state and local regulations and their potential overlap with or increased stringency from federal regulations. Many new requirements applicable to the facility add pollution prevention/source reduction requirements, which can be met through process changes or changes in blending stock composition and additives, and may in themselves necessitate further changes.

Like most companies, refiners have a limited amount of capital to invest in plant improvements each year. Investments in environmental compliance are part of this budget. So if environmental regulations are more stringent, complex, or costly than is necessary, they use corporate resources that could otherwise be devoted to other projects. This can delay or eliminate further upgrades and other investments that would ultimately make refineries more efficient, or lower pollutant by-products. It also reduces the money available to the industry to invest in research and development needed to develop better fuels and increase productivity. Consequently, the petroleum industry supports doing what is needed to protect human health and the environment, but wants to be assured that environmental benefits commensurate with the costs have and will result from the expenditures it is being asked to make.

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Despite the confusing array of environmental regulations, real progress is being made. Since 1988, the volume of toxic pollutants emitted by refineries has declined by 26 percent.[3] [This comparison is for substances that have been included on the Toxics Release Inventory (TRI) list since 1988.] Compliance with more stringent requirements accounts for much of this decline, but a large portion is also attributable to voluntary programs that companies have implemented to control their emissions. Further reductions, whether required by regulation or company action, will be far more expensive and difficult to obtain than those accomplished to date.

Beginning in 1995, the number of substances that must be reported under the TRI nearly doubled. Despite this large increase in the number of substances reported, the total volume of releases from refineries for all listed chemicals grew by only 10 percent. Releases of many of these newly listed compounds have been reduced as part of ongoing pollution prevention efforts. But like all chemicals, continued reductions eventually become very difficult and expensive to achieve.

[3] Based on data from the Toxic Release Inventory for 1995, as cited in American Petroleum Institute, *Petroleum Industry Environmental Performance, Fifth Annual Report.* May 1997.

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IV. FUTURE REQUIREMENTS ON REFINING INDUSTRY

The impact of environmental regulations is typically evaluated in isolation, and an individual change may not always appear to have a major effect. But the cumulative effect of numerous environmental regulatory changes is substantial. The U.S. refining industry is in the process of complying with several major regulatory changes that have been promulgated in the past several years. They are also gearing up to address the second phase of reformulated fuels requirements, and several new requirements under development. The cumulative effect of these changes is substantial, requiring both process changes and additional controls. The need for process changes is multiplied in additional environmental costs, since modifications to the plant require modifications to existing operating permits both for the construction period and for operations after the modification. Obtaining permit revisions can be a lengthy and expensive process, which has been lengthened by the conversion to federal permits and the growing burden on state agencies. Here especially, conflicting state and federal requirements can create difficulties for refineries, as they did in California as refiners began preparations for the first phase of reformulated fuels requirements.

For this analysis, pending requirements that can add to refiner's cost of compliance have been divided into two groups: requirements recently promulgated, for which compliance is underway, and requirements currently being developed by EPA. The first group includes a range of requirements promulgated over the past two years, most of which provided three years for refineries to come into compliance. The second group includes regulations that target the refining industry specifically and regulations that effect refiners along with other industries. All of the regulations in the second group are currently underdeveloped. This analysis focuses on compliance requirements related to wastes, effluents, or emissions from the plant itself; it does not examine fuels-related requirements in detail, but does discuss them in general terms. A broader list of pending regulatory actions, most of which are not considered in this report, is shown in Appendix C.

For the first group of regulations, available cost data from EPA or refiners who have already begun to implement these requirements have been used to characterize the cost to the refining industry. For the second group of regulations, this analysis develops specific engineering-based estimates of the cost of compliance with the likely changes to be required. For the latter group, there is inherently some uncertainty associated with what the final requirements are likely to be. Nonetheless, a reasonable (not worst case) approach or range of possible outcomes has been used as the basis for developing costs.

A. Description of Recently Promulgated Requirements

Five major regulations that affect refiner's compliance requirements have been promulgated over the past two years. Compliance with these requirements is currently underway and will be complete by late 1998. These costs are incremental to the current expenditures previously discussed. They will affect refiner's profitability and at least a portion of the cost will need to be passed along to the consumer in the form of higher prices if refineries are to remain in business. All five of these new regulations are a result of the Clean Air Act Amendments of 1990. Three of the five are maximum achievable control technology (MACT) requirements for control of, or national emission standards for, hazardous air pollutants (HAPs) under Section 112 of the CAAA. Each of the five regulations is discussed briefly below, along with available estimates of the cost of this regulation to the industry for four of the five.[4]

Refinery MACT. In August 1995, EPA finalized requirements for the control of hazardous air pollutant emissions from most of the process units at refineries (the remaining units are the subject of a separate rulemaking — see below). HAPs were targeted in Section 112 of the Clean Air Act due to the perceived health effects of exposure, although industry has argued that scientific demonstration of these

[4] This portion of the analysis relies on published cost estimates or simple calculations. Costs for recently promulgated regulations have not been estimated using the engineering costing approach that was used for future requirements.

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effects at low concentrations is weak. As a potentially large source of reductions, refineries were an early target of the series of MACT rulemakings for control of HAPs.

This rulemaking requires that certain process vents at refineries install control equipment that reduces HAP emissions by 98%. Storage tanks are required to be retrofitted with an internal or external floating roof or with an external control device (e.g., flare, vapor recovery unit). HAPs from wastewater streams must meet threshold levels or be reduced to acceptable levels using steam stripping, biotreatment or other treatment or recovery technologies (if not already accomplished under a prior rulemaking). Refiners are also required to implement leak detection and repair (LDAR) programs. Refiners must make the appropriate modifications to be in compliance by August 1998, except for storage tanks, which must be retrofitted at their next cleaning, but by August 2005 at the latest.

According to EPA's analysis for the rulemaking, the capital cost associated with compliance will be $213 million. In addition, annual costs of $79 million are likely, $59 million for the operation and maintenance of control devices and $20 million for monitoring, record keeping and reporting. Based on preliminary data from companies who have begun to implement the requirements, EPA's costs may be low.

Marine Terminals MACT. As marine vessels are loaded and unloaded, vapors are released to the atmosphere. In late July 1995, EPA promulgated a rule to prevent these releases, requiring that certain vapors either be recovered (through some type of condenser) or burned (using a flare). Compliance with this regulation is phased in through August 1999, with the date of compliance depending on the type of source.

Not all marine terminals are located at refineries, but many refineries do have marine loading and unloading facilities that would be covered by the rulemaking. EPA estimated that the total capital costs associated with this regulation could be between $266 million and $440 million. Annual costs are expected to be between $60 million and $100 million. Assuming that 25% of marine terminals are located at refineries, the cost to refiners of this rulemaking would be $66.5 million to $110 million in capital costs and $15 million to $25 million annually.

Risk Management Programs. Due to concern that a major chemical release could occur in the U.S., Congress included in the CAAA a requirement that EPA establish requirements to prevent accidental releases of hazardous chemicals and reduce the severity of releases that do occur. This resulted in a June 1996 final rule on risk management programs. While the rule permits three levels of regulation based on risk, with correspondingly more stringent requirements, refiners, due to the nature of the substances handled, fall into the most stringent category. Refiners must implement risk management programs that require a detailed hazard assessment of the offsite consequences of a worst case accidental release, additional training and drills for employees, coordination of response procedures with community response organizations, development of a risk management system, and implementation of a prevention program identical to the Process Safety Management (PSM) program of the Occupational Safety and Health Administration (OSHA).

When RMPs were proposed, API submitted comments on the rulemaking. While the rulemaking significantly improved from the original proposal, the requirements facing refiners changed modestly. API estimated the initial cost of compliance for the refining industry to be between $185 million and $555 million.[5] Ongoing, annual costs were estimated by API to be small, since most of the annual costs fall under the PSM program, with which refineries already comply. Refiners must incur these costs before the compliance deadline of June 21, 1999.

Title V Air Permits. Although refinery operations were already covered under state permits, the CAAA mandated a federal permitting program under Title V. This has required modification to state

[5] American Petroleum Institute, "Comments of the American Petroleum Institute on the Environmental Protection Agency Notice of Proposed Rulemaking on Risk Management Programs for Chemical Accident Release Prevention," February 16, 1994.

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permitting programs and the necessity to reapply for permits, which is time consuming and costly. States are in the process of implementing Title V programs; the first facilities began compliance during 1996. All refineries are expected to require Title V permits over the next 2-3 years as states fully implement the program. The Title V program requires permitting of many units or facilities that were previously "grandfathered," and not subject to permitting requirements (although they were still subject to emission standards). The cost of collecting the necessary information and completing permit requests for these facilities is substantial. The cost to a facility to develop the initial Title V submittal ranges from $100,000 to $300,000 per refinery for most facilities. Some larger facilities that may have been previously grandfathered have been much more expensive — in one case, Title V permitting costs have exceeded $1 million for a single refinery that required multiple permits.

No published estimates of Title V costs for the entire refining industry are available. An estimate has been developed using a simplistic, conservative assumption that refineries under 25,000 b/d cost $50,000 to permit, refineries of 25,000 b/d to 100,000 b/d cost $100,000 to permit, refineries of 100,000 b/d to 200,000 b/d cost $200,000 to permit, and refineries over 200,000 b/d cost $300,000 to permit. On this basis, the total cost of Title V permitting to the entire refining industry is estimated conservatively as $22.2 million. This represents the initial cost of obtaining Title V permits. It does not include the cost of activities required to maintain the permit (monitoring or other requirements) or for permit modifications, such as those that may be necessary to make the modifications required to comply with other regulations examined in this analysis. Approval of modifications to a Title V permit (e.g., for construction of a new unit or efficiency modifications at an existing unit) can take two to three times as long as previously required for a state permit.

Offsite Waste NESHAP. Because of concern about the potential for HAPs emissions from waste treatment facilities, EPA has promulgated national emission standards for hazardous air pollutants (NESHAP) from offsite waste treatment facilities. While these standards apply directly to refineries only when waste is sent from one refinery to another refinery for treatment, they do affect the costs refiners must pay for waste disposal. The NESHAP apply to facilities that receive specified wastes, used oil, and used solvents from off-site locations for storage, treatment, recovery, or disposal. Controls are specified for tanks, surface impoundments, containers, oil-water separators, individual drain systems, material conveyance systems, process vents, and equipment leaks. Reporting and recordkeeping requirements also apply. The cost to refiners of this rulemaking is not available, but it will raise disposal costs for the 1 million tons of refinery wastes disposed annually.

B. Cost of Recently Promulgated Requirements

Refiners have begun making the expenditures necessary to comply with the recently promulgated requirements discussed above. Most, however, will incur these costs over the next 24 months. These expenditures will require a significant portion of the capital budget of affected refineries, and will lower operating margins unless product prices rise.

Together the four recently promulgated rulemakings for which costs are available (refinery MACT, marine terminals MACT, RMP, and Title V) have a conservatively estimated cost to the refining industry of $487 million to $900 million in capital costs and $94 million to $104 million in incremental annual operating, maintenance, reporting and recordkeeping costs. On an annualized basis,[6] these four regulations could add $157 million to $221 million to refining industry compliance expenditures, an increase of around 3% over current expenditures.[7] This translates to $929,000 to $1.31 million increased

[6] Costs are annualized assuming a 15 year life and 10% interest rate, for a capital recovery factor of 0.13.

[7] Comparison is made with the $5.7 billion spent by the refining industry in 1995, as reported in: American Petroleum Institute, *Petroleum Industry Environmental Performance, Fifth Annual Report*, May 1997.

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cost per refinery on an annualized basis (assuming that each paid the same cost).[8] On a cost per barrel basis, these costs translate to roughly a 10% decline in the cash operating margin experienced in 1995.

As previously noted, it is not possible to estimate a particular refinery's costs because there are many factors that need to be considered. However, the following estimates are based on conditions expected at some refineries. A hypothetical 100,000 b/d refinery could incur $3.2 million to $8.1 million in additional capital costs and between $613,000 and $678,000 in increased operation and maintenance costs annually for compliance with these rulemakings. On an annualized basis, this hypothetical refinery's compliance outlays could rise by $1.0 million to $1.7 million. This is incremental to the estimated $37.1 million this hypothetical refinery currently pays for environmental compliance.

C. Description of Future Requirements

The focus of this analysis was to estimate, in as much engineering detail as possible, the cost of compliance with several rulemakings that are currently under development at EPA that will force refiners to make additional compliance expenditures over the next several years. This analysis considers only a subset of the numerous actions that could affect refineries (see Appendix C). Two of the regulations examined are specific to the refining industry. The others are all general regulations that will affect refineries along with numerous other industries or are revisions to national standards that will necessitate changes at the state level that are likely to affect refineries. All of these issues are complex. Many have not yet reached the proposed rule stage. Without a specific proposal to evaluate, it has been necessary to make assumptions about the likely requirements or a range of possible requirements. In all cases, this analysis has tried to avoid a "worst case" characterization of the future. This means that the costs estimated are a realistic assessment of future costs of compliance, and that costs could be higher if any of these requirements is more stringent than assumed herein.

Each of the future requirements considered in this analysis is described below. The costs of these future requirements are estimated in the following section. It should be noted that the regulations listed below are only a portion of those currently under development. Additional requirements are sure to be added in the future, increasing compliance costs. It should also be noted that the future requirements considered include only waste management and air emission controls. Health and safety requirements at refineries have not been considered in this analysis.

Hazardous Waste Listing. Under the Resource Conservation and Recovery Act (RCRA), EPA is evaluating several residual streams generated by the refining industry to make a determination whether they should be "listed" as hazardous wastes. Currently, under RCRA, waste streams that are not specifically listed as hazardous wastes are tested to determine whether they exhibit any hazardous characteristics. The management of each waste is determined by whether it is hazardous or non-hazardous. "Listed" hazardous wastes must always be managed as hazardous, whether or not the actual waste sample exhibits hazardous characteristics. Seven refinery waste streams have been listed as hazardous for a number of years.

In 1988, the Environmental Defense Fund sued EPA and obtained a consent decree requiring a final listing determination by October 31, 1996 for 14 specific refinery residuals. On November 20, 1995, EPA issued a proposal to list three refinery residual streams as hazardous, and requested comments on the possible listing of a fourth residual stream. Several management options were discussed. After receiving an extension, EPA now plans to finalize this rule in April 1998.

This analysis assumes that only the three proposed residual streams (clarified slurry oil storage tank sludge, spent hydrotreating catalyst, and spent hydrorefining catalyst) are listed in the final rulemaking. This analysis further assumes that EPA selects the management option that requires Subtitle C disposal of all of these residuals and accounts for land disposal restriction (LDR) costs. In this

[8] Based on total of 169 refineries, as reported in *Oil & Gas Journal*, "Worldwide Refining Report," December 18, 1995.

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alternative, it is assumed that Subtitle C incineration, along with recycling/reclamation of catalysts will be used. In a few cases, where it is economically advantageous, refiners may use on-site incineration, but most facilities will choose to incinerate their residuals off-site.

The compliance costs associated with this rulemaking derive from the incremental costs of handling and disposing of the listed residual streams as hazardous wastes. Over 75% of refineries produce one or more of these potentially listed residual streams. These companies would be required to alter their current storage, treatment, transfer, and disposal management practices to manage these residuals in compliance with Subtitle C of RCRA, with ultimate disposal in a permitted hazardous waste incinerator for all materials that could not be recycled/reclaimed.

There is the possibility that EPA could review another group of refining residuals to make a listing determination. EPA has completed a required study of these additional residual streams. There is no indication, at this time, that EPA plans any further actions with regard to these residuals. For purposes of this analysis, it has been assumed that no additional residuals will be listed. However, if additional residuals were listed, refiner's compliance costs would increase from those shown in this analysis.

Compliance Assurance Monitoring. Under the CAAA, EPA was required to promulgate a means for assuring that companies remained in continuous compliance with all applicable requirements for air emissions. As the MACT rulemakings have been developed for control of HAPs, monitoring methods have been incorporated as part of the rulemaking. But for other emission sources (sources of pollutants such as NO_x, SO_2, volatile organic compounds, CO, and particulate matter), EPA has been working to develop a compliance assurance monitoring (CAM) program (previously called enhanced monitoring).

The highly controversial CAM rulemaking has been proposed, reproposed, and withdrawn over the past several years, leading to several extensions of a court mandated deadline for completion. In August 1996, EPA began circulating a new draft CAM proposal to obtain comments prior to its proposal in the *Federal Register*. This analysis assumes that EPA promulgates a CAM rulemaking similar to this 1996 draft. The rule is scheduled for promulgation in early October 1997.

Under the CAM rulemaking, refiners could be required to add compliance monitors on process vents that do not already have them. Reporting and recordkeeping requirements would also be imposed. Some process vents already have analyzers or opacity monitors installed. Whether these units would be sufficient or would require replacement depends in part on the age of the equipment, whether they measure at a sufficient level of precision for EPA requirements for particular pollutants, whether they can be modified to track other pollutants of concern, etc. The draft proposal is not specific about the exact technologies to be required; rather a monitoring plan for each facility must be approved by EPA. These plans can include a range of different monitoring approaches, as long as EPA is satisfied that emissions from the facility are being sufficiently monitored.

To comply with this rulemaking, some units in the refinery may require no additional equipment, some will require modification, and some will require the installation of new monitoring equipment. To generalize for this analysis, a range of new installations has been assumed. Costs have been developed assuming that each refinery would have to install 4, 5, or 7 new emission monitoring units. Although the analysis includes costs for new installations only (the cost of modification would be different for every unit), it is assumed that the *range* of costs estimated represents the mix of new installations and modifications that each refinery might face to comply with this rulemaking.

Refinery MACT II. In promulgating MACT requirements under the CAAA, the refining industry was separated into two parts. The first, promulgated in August 1995 (see above), covered all process units at refineries except catalytic cracking units, catalytic reformers, and sulfur plants. These three process vents are covered in this second rulemaking (MACT II). EPA has circulated a draft of likely requirements (presumptive MACT) applicable to these three types of process units at refineries. This presumptive MACT has been used as the basis for assumed requirements in this analysis. EPA is planning to make a formal proposal in 1997. The rule is scheduled to be finalized by the end of 1998.

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This regulation will limit organic and inorganic hazardous air pollutants (such as hydrogen chloride, carbonyl sulfide, carbon disulfide, metals) emissions from the covered process vents. The assumed control technologies are those recommended in the presumptive MACT. The potential cost of this regulation to industry was calculated by assuming that EPA may require that the three process vents would have to be outfitted with the following control technologies, unless they were already outfitted with an acceptable technology: every FCC regeneration vent would be equipped with an electrostatic precipitator (ESP) and a CO boiler (or complete CO combustion); each catalytic reformer unit regeneration vent would be equipped with a caustic wet scrubber and a thermal oxidizer; and each sulfur plant unit vent would be equipped with an incinerator or thermal oxidizer. All refineries with these operations would be required to comply with the regulation, unless their current operations are in compliance with the new standards. EPA's proposed MACT standards may vary from these assumptions.

While some refineries may already have certain equipment (e.g., ESPs) installed, this equipment may not be capable of meeting the stringent emission limits of this rulemaking. This could require that these units be upgraded or replaced to come into compliance with the rulemaking. For purposes of this analysis, it has been assumed that all refineries in California would meet the emission limits of this rule since they already comply with stringent state emission standards. If, however, some of these refineries are unable to meet the new standards and have to upgrade or replace equipment, the costs estimated in this analysis are understated.

Industrial Combustion Coordinated Rulemaking (ICCR). The Clean Air Act (section 111) requires that EPA establish new source performance standards (NSPS) for control of criteria pollutants (such as SO_2, NO_x, particulate matter) for various industrial sources of emissions. Under section 112, the Clean Air Act also requires EPA to promulgate national emission standards for hazardous air pollutants (NESHAP). Hazardous air pollutants (HAPs) include over 180 pollutants of concern, including benzene, toluene, and formaldehyde. The NESHAP are required to be based on maximum achievable control technology (MACT).

EPA recognized that for some industrial sources there was the potential for overlap between these two requirements. As a result, EPA is developing a combined rulemaking that will establish (or revise) NSPS and establish NESHAP for seven industrial source categories: industrial boilers; commercial/institutional boilers; process heaters; industrial/commercial solid waste incinerators; other solid waste incinerators; stationary gas turbines; stationary internal combustion engines. While EPA refers to this rulemaking as the Industrial Combustion Coordinated Rulemaking (ICCR), industry sometimes refers to it as "Combustion MACT." For the refining industry, the primary effect will be controls on process heaters and boilers, but certain other equipment could also be affected (e.g., gas turbines, large engines).

EPA has brought together an advisory group to assist in the development of this rulemaking, which EPA plans to finalize by November 2000. The combined rulemaking is intended to control both criteria pollutants and HAPs; different technologies may be appropriate for each. It is still too early in the process for any concrete proposals to have been made or discussed. Therefore, for this analysis, a *range* of options using available control technologies has been assumed to account for the uncertainty regarding the requirements that will ultimately be proposed.

EPA has indicated that it plans to evaluate 15 different technologies for their applicability under this rulemaking. For some of the sources covered by the rulemaking, industry is concerned that technology options for controlling HAPs are limited. For this analysis, two scenarios have been developed to establish a range of possible costs using *available* technologies, regardless of the effectiveness of these technologies for control of HAPs. Use of these technologies for developing costs should not be construed as an endorsement of their use for controlling HAPs. Recent API research has shown that these technologies do not control HAP emissions, although they could be used for NO_x control under NSPS. The scenarios are based on the following assumptions: 1) installation of selective catalytic reduction (SCR) units on heaters and boilers, and 2) installation of low NO_x burners on heaters and boilers. The lower cost scenario was used in the economic analysis.

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One additional requirement that could potentially accompany the ICCR is a prohibition on the use of residual fuel oil, and potentially diesel fuel oil, as a fuel source in refineries. [Fuel type can have a large *impact on the type and level of HAPs emissions for some sources.*] Currently, around 2% of refinery fuel is provided by residual fuel oil, with minor amounts provided by diesel fuel. For purposes of this analysis, no attempt has been made to develop the cost for a requirement to replace these fuel sources with natural gas or refinery gas. If this requirement was imposed, costs would be incremental to those developed in this analysis. Another stringent possibility could be a requirement to substitute natural gas for refinery gas (as well as liquid fuels). Such a requirement could be enormously expensive, and no attempt has been made in this analysis to develop the costs of this option.

SO_2 NAAQS. Periodically, EPA is required to reexamine, and may propose changes to, national ambient air quality standards (NAAQS). These standards set air quality standards for criteria pollutants. Areas of the country (typically by county) are then judged to be in compliance with the NAAQS (attainment) or not in compliance (nonattainment).

EPA has spent the last several years trying to determine whether or not the current sulfur dioxide (SO_2) NAAQS are "requisite" to protect human health and the environment. EPA affirmed the existing SO_2 NAAQS in May 1996. However, EPA has proposed a set of guidelines for states to follow in setting up their own intervention programs to protect asthmatics and others with respiratory disorders. The program would allow states to design their own programs. However, EPA would retain the authority (under Sections 301(a) and 303 of the Clean Air Act) to intervene if a state fails to address a measured short-term peak SO_2 problem.

A key element of the proposal is the relocation of existing SO_2 monitors to areas near point sources where peak SO_2 concentrations may exist. EPA suggests that the monitors be relocated to be near a number of industry categories that have the potential to emit SO_2. This list of facilities specifically includes petroleum refineries.

The proposed program would establish four concentration levels to provide a basis for action by the states. These levels would range from a five-minute peak SO_2 concentration of 0.60 ppm (concern level), to a level of 2.0 ppm (endangerment level). EPA believes that when a 0.60 ppm level has been exceeded in a given area, the state should consider whether or not the situation presents a significant public risk. Suggested implementation and enforcement actions would become more stringent as the threshold levels are exceeded. Suggested actions include facility audits and investigations to assure compliance with existing emissions regulations and sound management practices. After an audit, the state authorities may choose to require corrective action such as better maintenance of control equipment, better capture of fugitive emissions, raising stack height, etc.

Because of the wide range of options available to each state, it is difficult to project the exact requirements that refiners will face if the rule becomes final as proposed. In addition, it is impossible to accurately predict which states may adopt the EPA guidelines, or to what extent. For this analysis, a list of states that currently have an SO_2 attainment problem was compiled. Based on the stringency of current state programs, level of environmental activism in the state, and consultations with industry personnel, a subset of these states with non-attainment areas were selected as being more likely to adopt and implement the program. The assumption that Indiana, Kentucky, Minnesota, Montana, New Jersey, Ohio, Pennsylvania, and Utah may adopt the program has been used to determine the impact on the refining industry for this analysis.

If a state determines that short-term peak SO_2 emissions are a problem at a given refinery, they would have a range of options to address the emission under the proposal. These options include mandating process changes, mandating installation of control technologies, or nothing at all.[9] This

[9] These options, their applicability, and their cost-effectiveness are discussed in: American Petroleum Institute, *Assessment of the Cost to the Petroleum Refining Industry of Compliance with Short-term Sulfur Dioxide NAAQS*, prepared by Systems Applications International Inc., EnSys, Inc., and ICF Resources, Inc., September 29, 1995.

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analysis has not attempted to determine whether any specific refineries have emissions that could trigger concern; compliance with new requirements is assumed for all refineries within the states assumed to adopt more stringent requirements. However, since larger refineries are more likely to be a source of concern, costs have been calculated for two scenarios: 1) assuming that all refineries in affected states have to comply, and 2) assuming that only refineries of 100,000 b/d or larger have to comply. Compliance is assumed to require installation of a wet gas scrubber (WGS) on catalytic cracking unit regeneration vents.[10]

Ozone NAAQS. On June 12, 1996, EPA issued an advanced notice of proposed rulemaking (ANPR) of its intention to review and potentially revise the current ozone NAAQS standard. The current ozone standard is a 1-hour 0.12 ppm concentration limit with one permitted annual exceedence. The ANPR states that the Clean Air Scientific Advisory Committee (CASAC) has concluded that the current standard is insufficient to protect human health and the environment and that the committee recommends the adoption of an 8-hour standard. CASAC further recommends that the new 8-hour primary standard be in the range of 0.07 to 0.09 ppm with between 1 and 5 allowable annual exceedences.

On July 18, 1997 (62 FR 388856), EPA concluded that the current primary standard is not adequate to protect the public form adverse health effects. In place of the existing standards, the agency proposed an 8-hour standard set at 0.08 ppm. Under the new standard, an area would be in non-attainment when the 4th highest daily maximum 8-hour concentration averaged over 3 years is above 0.08 ppm (this is roughly equivalent to three allowable exceedences). However, EPA left the existing 1-hour, 0.12 ppm standard in place for all areas that currently are in non-attainment with the 1-hour standard. For those areas, the 1-hour standard will continue to apply until those areas reach attainment. At that time, the 1-hour standard will cease to apply to those areas.

The number of areas affected by the proposed ozone NAAQS could be substantial. Currently there are 245 ozone non-attainment areas in the country. Under the proposed ozone standards, API projects that there could be as many as 524 non-attainment areas.

The new standards will need to be incorporated into State Implementation Plans (SIPs). Each state may pursue a range of EPA approved options to reduce NO_x and VOC emissions to bring the state's air quality into compliance with the new standard. The strategies selected by each state will vary based on the nature of the air quality problems in the state and how they may be affected by each available reduction option. As such, it is very difficult to project the exact requirements with which refiners will need to comply as a result of the change to the ozone NAAQS.

In addition to the specific control requirements that could be imposed, revision of the ozone NAAQS could have other effects on refineries. Since many new areas would be expected to be unable to comply with the new standard, new non-attainment areas could now require the use of low reid vapor pressure (RvP) gasoline or reformulated gasoline (RFG). This could require that the refineries serving these regions make investments in the production and distribution of RFG. This analysis has not attempted to quantify these costs, but because major capital investments could be required, this expansion of coverage for RFG requirements could potentially be more expensive for refineries in these areas than the controls for which costs have been developed below.

This analysis, which was prepared before the final rule was issued, assumes that EPA promulgates a new 8-hour 0.08 ppm, 3rd highest daily maximum standard. This is slightly more stringent than the final requirements, but should not materially affect the cost estimate. A new ozone NAAQS would likely cause many areas that are in attainment with the current standard to be redesignated as non-attainment areas. In addition, areas that are currently designated as non-attainment could become more severely out of attainment when compared to the new standard. The revised NAAQS is likely to lead to new ozone reduction programs in newly designated areas, and more stringent control strategies and

[10] This control technology is an alternative to the electrostatic precipitators (ESPs) assumed to be installed on fluid catalytic cracking units under Refinery MACT II. See the section on costs below for a discussion of how this potential overlap has been handled.

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technologies in existing non-attainment areas, as they attempt to meet first the old standard and then the new requirements. The likely measures would include a variety of emissions control technologies to limit nitrogen oxide (NO_x) and volatile organic compound (VOC) emissions from various sources in the non-attainment area. As major industrial sources, petroleum refineries are expected to be one of the main targets for controls.

This analysis assumes that refineries will be required to install an array of pollution control measures including installation of low NO_x burners and implementation of a stringent Leak Detection and Repair (LDAR) program. The analysis also assumes that requirements will be more stringent in existing non-attainment areas than in new non-attainment areas. The specific control options used in this analysis are outlined below:

- *Refineries in existing non-attainment areas*: For NO_x reduction, ultra-low NO_x burners (ULNBs) are assumed to be required on all natural draft heaters. Selective catalytic reduction (SCR) units will be required on all mechanical draft heaters and refinery boilers.[11] For VOC reduction, all refineries in this category will be required to implement a more stringent LDAR program that uses a leak definition of 1/2 the current standard and doubles monitoring requirements.[12]

- *Refineries in new non-attainment areas*: For NO_x reduction, all natural draft heaters will be required to install ultra-low NO_x burners (ULNBs) and all mechanical draft heaters and refinery boilers will be required to install SCR units.

PM NAAQS. EPA also has revised the current NAAQS for particulate matter (PM). The current standard requires control of PM greater than 10 microns in size (PM-10). Due to concerns about the health effects of small particulates, on December 13, 1996, EPA proposed adding a new standard to control PM-2.5 (particles of 2.5 microns or smaller). Changes to the 24-hour PM-10 standard were also proposed. On July 18, 1997, EPA finalized the proposed changes to the NAAQS. PM-2.5 will now require controls.

Industry does not believe that a PM-2.5 standard is justified by the scientific data EPA used for the rulemaking, and EPA's proposal met with substantial criticism. Moreover, industry does not believe that such a standard could be met in all areas with currently available technologies. Many refineries currently use electrostatic precipitators (ESPs) for control of PM. The Refinery MACT II rulemaking (see above) will lead to upgrade or replacement of existing ESPs to control PM from fluid catalytic cracking catalyst regeneration vents. But these ESPs have not been demonstrated to control PM-2.5. The best available technology for control of PM is wet gas scrubbers (WGS), although their performance against a PM-2.5 standard is questionable.

Existing state implementation plans (SIPs) will have to be revised to reflect the new standard for PM-2.5 control. States will have some flexibility in implementing the standard, but more stringent requirements will reduce the amount of flexibility available. It is difficult to be certain what requirements refiners may face and the extent to which any differences may exist by state. However, given the likely stringency of the new standard and the limited technological options for meeting that standard, the assumption that a WGS will be required seems reasonable to represent the level of costs that refiners may face.[13] The WGS would be installed on the regeneration vent from fluid catalytic cracking units.

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[11] A distinction in the control technologies has been made because SCR units cannot be easily added to natural draft heaters. Therefore, natural draft heaters are assumed to use ULNBs.

[12] These assumed requirements are based on an analysis performed for API: A.S.L. & Associates, "Socio-Economic Study of Possible Eight-Hour Ozone Standard," June 4, 1996. California's LDAR program, for example, has a leak definition of 1/2 the current standard, but with the same monitoring requirements.

[13] This control technology is an alternative to the electrostatic precipitators (ESPs) assumed to be installed on fluid catalytic cracking units under Refinery MACT II. A WGS could also be required under state

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PM-2.5 and its precursors are primarily products of combustion. Efforts to control PM-2.5 could potentially result in added pressure to replace liquid fuels or reduce their usage. This could harm refiners by reducing the potential market for their products.

Release Prevention Barriers on Above Ground Storage Tanks. Because of a few highly publicized leaks and spills from storage tanks since the late 1980s, legislation is typically introduced in every session of Congress that would require the retrofit of above ground storage tanks (especially the large ones) with release prevention barriers as an extra spill prevention measure. EPA, as part of its Spill Prevention, Control and Countermeasures (SPCC) program, has also recently conducted a survey of tank construction to determine whether additional construction requirements are warranted. Several states have also proposed adding construction requirements for storage tanks to provide additional assurance against spills of crude oil or refined products.

Release prevention barriers can include a range of construction methods to install protective materials inside the tanks between the existing tank bottom and a new tank bottom or beneath the existing tank bottom. They are designed to prevent the escape of the fluids in the tank, and to contain or channel any released material for leak detection. All new tanks would be constructed with release prevention barriers and existing tanks could be retrofitted. Examples of new construction or retrofit methods include:

- Steel tank bottom, placed over a layer of sand containing perforated piping to channel any released material to monitoring equipment, placed over an impervious barrier (such as a clay or synthetic liner) placed over the existing tank bottom

- Steel tank bottom, placed over a layer of concrete with grooves radiating to the outside circumference and monitoring equipment, placed over an impervious barrier, placed over the existing tank bottom.

In early 1997, EPA began circulating a draft notice of a proposed program for a voluntary Oil Cooperative Program. This program is an outgrowth of EPA's study of secondary containment that was mandated by section 4113(a) of the Oil Pollution Act of 1990. At this time, EPA is considering use of a voluntary program rather than a formal rulemaking. The stated goals for companies participating in the Oil Cooperative Program are to: 1) address known contamination and assure that existing contamination will not be allowed to migrate offsite; 2) report the status of facility contamination and actions underway to address any problems to appropriate government agencies; 3) adopt the most protective appropriate prevention standards and upgrade equipment as necessary; and, 4) monitor and/or implement leak detection to ensure that new leaks are addressed. EPA's current draft does not discuss appropriate prevention standards or which might be considered "most protective" at various types of sites. While API supports the concept of voluntary programs as an alternative to inflexible regulations, it is unclear at this time to what extent RPBs might still be "required." If alternative measures are found to be appropriately protective, costs could be reduced from those estimated in this analysis.

This analysis assumes that through either federal or state action, or as part of their participation in a voluntary program, refiners will retrofit their storage tanks with release prevention barriers. Based on an analysis previously conducted for API, a range of costs has been assumed which reflects the cost of the various types of release prevention barriers that could potentially be required. Only the capital cost of the retrofit has been included. A tank constructed with release prevention barriers would have slightly increased annual operating costs for the monitoring equipment, but these costs have not been included. It has further been assumed that any regulation would allow retrofit to be completed at a normal out-of-service period, so that no additional costs for downtime were incurred.

Other Major Requirements. The refining industry faces several other possible environmental requirements for which costs have not been developed for this analysis. Costs were not developed for

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implementation of new SO_2 standards. See the section on costs below for a discussion of how this potential overlap has been handled.

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these requirements because their impact is even more site-specific than the requirements discussed above.

Wastewater Requirements. Several actions are underway or have been considered by EPA that could potentially increase the costs of refineries for wastewater treatment, handling, and disposal. Currently, wastewater discharges from refineries are either permitted by state or federal agencies under the National Pollution Discharge Elimination System (NPDES) or wastewater is discharged (30% of refineries[14]) to a public-owned treatment works (POTW) that sets standards for the effluents it receives. Current NPDES permits must be at least as stringent as federal effluent guidelines established for the refining industry.

EPA is currently working on new requirements for setting water quality standards. The water quality standards that are set will be specific to particular water bodies based on the pollutants of concern in that watershed. Tighter water quality standards will lead to a tightening of permit requirements and a reduction in the pollutants allowed in refinery wastewater. Removal of these pollutants will require the installation of additional treatment technology, but the technology required will depend upon the pollutant of concern. The pending changes have the potential for imposing substantial costs on the refining industry, depending on the pollutants of concern in each area.

In 1994, EPA released its contaminated sediments management strategy. In it, EPA makes clear that it plans to identify contaminated sediments and pursue a remediation strategy, likely imposing the costs on those perceived to be responsible. Three of the first five substances for which sediment quality criteria have been proposed are petroleum-related. The timing of any actions under this program is unclear, but EPA seems dedicated to moving forward, building from the initial sediment-related requirements that were part of the Great Lakes Water Quality program.

EPA recently considered reexamining the national effluent guidelines that form the minimum standards for NPDES permitting of wastewater discharges. EPA collected some information and released a document on the level of pollutants that may exist in refinery discharges. They have not shown any inclination to move forward with a revision to the guidelines at this time, but this remains another area where costs to refiners for wastewater management could increase in the future.

Developing specific costs for possible increases in wastewater management requirements was not feasible for this analysis, given both the site-specific nature of impact and the uncertainty associated with the requirements that may be promulgated. Many of the initiatives being pursued are consistent with those applied in the Great Lakes as part of the Great Lakes Water Quality Guidance program. While it is generally agreed that the Great Lakes represent a unique watershed, available data on the estimated cost to refiners of compliance with the Great Lakes program requirements can provide a high side estimate of possible future wastewater costs based on the many things currently being considered. Four Great Lakes area refineries that responded to a survey by the Ohio Petroleum Council estimated their cost of compliance with the Great Lakes Water Quality program at $78 million to $292 million in capital costs and $36 million to $64 million annually.[15] This translates to $19.5 million to $73 million in capital costs and $9 million to $16 million annually per refinery. While the costs imposed by possible water quality actions would likely be lower in other areas of the country, they still have the potential to represent significant costs to the industry that have not been included in this analysis.

Phase II RFG Requirements. The Clean Air Act Amendments that imposed RFG required a second phase, with further reductions in NO_x and VOC emissions, to take effect in 2000. Refiners will need to make major investments to develop the capability to produce Phase II RFG. To be ready, these investments will need to commence in 1997 or 1998. The Phase II RFG requirements could be the most

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[14] Environmental Protection Agency, *Preliminary Data for the Petroleum Refining Category*, Interim Final, July 22, 1994.

[15] Ohio Petroleum Council, *Survey of Estimated Costs of Compliance with the Great Lakes Water Quality Initiative*, January 15, 1993.

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expensive requirements facing those refiners who are covered by them. Most refiners will meet the new standards with additional hydrotreating. The cost of hydrotreating gasoline blending stock from an FCC unit can reach $25 million at a single refinery.[16] One company reports that it will comply with Phase II RFG requirements by modifying existing units for additional desulfurization, upgrading fractionation to remove heavier hydrocarbons from cracked naphtha, and increasing butane removal.[17] API has estimated that refiners will spend 3.8 cents per gallon to produce RFG II.[18] The planned changes to the ozone and PM NAAQs could lead to increased demand for RFG II, potentially requiring even more capacity investments.

D. Cost of Future Requirements

The potential cost of compliance with each of the future requirements described above was estimated using an engineering-based costing approach. The changes necessary for compliance were defined, and the cost of making those changes estimated based on the cost of required equipment, reporting, waste disposal, etc. Costs were estimated both as capital costs that would be required to come into compliance with the regulation and as incremental operating, maintenance, reporting and recordkeeping costs that would be incurred on an annual basis to remain in compliance. Appendix E provides the detailed cost development for each issue.

Since the focus of this analysis was the *cumulative* cost of environmental regulations, it has been necessary to consider that some of the regulations examined could require installation of similar technologies on the same emission source within the refinery. Rather than assume that refiners would install one technology, then a few years later scrap that to install another technology, this analysis has assumed some foresight by refinery operators in making their decisions about control technologies. The costs for three issues (SO_2 implementation plans, ozone NAAQS, and PM NAAQS) have been adjusted to account for this foresight and potential overlap with other regulations (Refinery MACT II and ICCR). The full cost of compliance with these issues (assuming that none of the other regulations occurred) has also been estimated separately (see Appendix F).

Table 1 summarizes the total refining industry compliance cost for the future requirements defined above. Costs are shown both without and with consideration of the overlap described above. If each regulation was promulgated individually, capital costs to the refining industry are estimated at $8 to $15 billion. On an annualized basis, costs could exceed $2 to 3 billion annually. These costs represent the high end (but not worst case) of costs that refiners could face in the future. To be conservative, the remainder of this analysis focuses on the lower, cumulative estimate that considers the overlap assumed in this analysis.

On a cumulative basis, the total capital investment required for the eight future regulations discussed above is $4.8 billion to $12.5 billion (1995 dollars). These expenditures would be made over several years, but still represent a substantial demand on the available funds of the industry, especially when refiners must begin making process changes to comply with Phase II RFG requirements by 2000 (costs that are not included above). These capital costs represent a substantial burden on the industry. To provide a basis of comparison, the higher end of the cost range is equivalent to around five new grassroots refineries (or major expansions) with a total capacity of 750,000 b/d.[19] Operating and maintenance costs could rise by $368 million to over $1 billion annually as a result of the regulations considered in this analysis. Other requirements not considered in this analysis could also increase compliance costs over the next decade.

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[16] "Refiners Gearing Up for Phase 2 RFG," *Oil Daily*, May 12, 1997.

[17] "Refiners Gearing Up for Phase 2 RFG," *Oil Daily*, May 12, 1997.

[18] Turner, Mason & Co., 1993.

[19] EnSys Energy Systems, Inc., *Impacts on U.S. Refining Industry of Environmental Emissions Compliance Costs*, June 1997.

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Table 1
Potential Environmental Compliance Costs
Total U.S. Refining Industry
Million 1995 Dollars

Initiative	Without Considering Technology Overlap[1]			Considering Overlap of Technologies[1]		
	Capital Cost	Annual Cost	Annualized[2] Cost	Capital Cost	Annual Cost	Annualized[2] Cost
Hazardous Waste Listing	0	27	27	0	27	27
Compliance Assurance Monitoring (CAM)	247 - 433	18 - 32	50 - 88	247 - 433	18 - 32	50 - 88
Refinery MACT II	1,227	45	211	1,227	45	211
Industrial Combustion Combined Rule (ICCR)	1,200 - 2,700	195 - 639	355 - 992	1,200 - 2,700	195 - 639	355 - 992
SO_2 Short Term Peak Levels State Implementation	220 - 305[3]	44 - 55[3]	73 - 94[3]	NA[3]	36 - 45[3]	36 - 45[3]
Ozone NAAQS	1,660[3]	311[3]	526[3]	588[3]	84[3]	160[3]
Particulate Matter NAAQS	1,350[3]	250[3]	425[3]	NA[3]	159[3]	159[3]
Release Prevention Banners on Above Ground Storage Tanks	2,700 - 7,500[4]	NA[5]	351 - 975[4]	2,700 - 7,500[4]	NA[5]	351 - 975[4]
Total All Initiatives	8,604 - 5,175	890 - 1,359	2,018 - 3,338	5,962 - 12,448	564 - 1,031	1,349 - 2,65

[1]Since several rules are still being developed, the exact requirements for compliance are not known. This analysis has used existing technologies as surrogates for possible future technologies. Costs for several of the rulemakings have been estimated using the same or very similar technologies. The first set of columns shows the potential cost of each individual rulemaking based on the assumptions in this analysis. The second set of columns accounts for the use of the same or similar technologies and avoids double-counting. This is a function solely of the assumptions used, not due to an expectation that the rules will actually be overlapping. The second, more conservative total was used in the economic analysis.

[2]Annualized using 15 year life and 10% interest rate for a capital recovery factor of 0.13.

[3]Costs for these rulemakings were developed using the same or similar technologies as other regulations. See Appendix E for a complete discussion of how potential overlap has been avoided for the cumulative cost analysis. Appendix F estimates the full cost that could potentially be associated with these rulemakings.

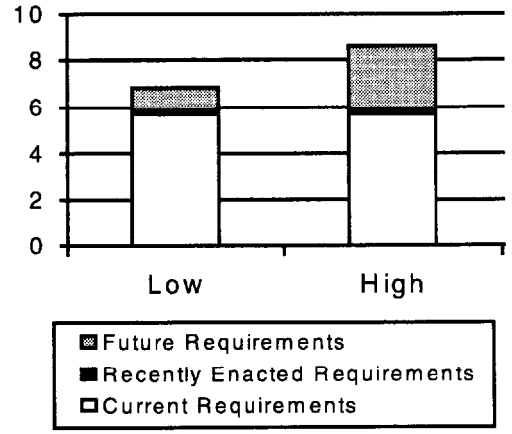
[4]The wide range is attributable to the 2 extremes examined in the study on which this analysis is based.

[5]Annual costs were not estimated.

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On an annualized basis, compliance with the eight regulations analyzed could add between $988 million and $2.65 billion to environmental expenditures by refineries. This represents a 17% to 46% increase over current environmental compliance expenditures by the refining industry.[20] The figure at right illustrates the growth of refining industry compliance costs from current costs to the estimated total after the eight regulations analyzed are implemented. If the costs of these regulations are similar to the estimates in this analysis, total environmental compliance expenditures by the refining industry could exceed $8.5 billion annually within the next 5-7 years (Figure 4).

Figure 4
Potential Environmental Compliance Expenditures of Refining Industry
Billion 1995 Dollars



Recent U.S. refining sector capital expenditures (for capacity additions, debottlenecking, and process improvements) have been around $4 billion per year.[21] The additional environmental requirements analyzed would reduce this capital budget, as available funds were expended on compliance. Capital projects compete against each other for funds. Mandatory expenditures for compliance would reduce funds available for discretionary projects. This implies that discretionary refining investments would have to meet a higher hurdle rate to receive capital budget funding. This could reduce refiner's ability to meet rising demand for refined products.

Table 2 illustrates the total cost to a "hypothetical" 100,000 b/d refinery that would be affected by all of these regulations (not all refineries would be affected by all regulations, but some would). This hypothetical refinery could need to invest $20.9 million to $29.99 million annually to install, operate and maintain new equipment to come into compliance with these future regulations if each were promulgated individually. Assuming that this refinery operates at 93% of capacity, these costs represent $0.62 to $0.88 per barrel of crude oil processed at the refinery. This cost exceeds the operating margins recently experienced by refineries, implying that without an increase in consumer prices, the refinery would be losing money on each barrel processed. For this refiner's economic health, some portion of the incremental compliance costs would have to be passed on to the consumer, raising the price of gasoline, diesel fuel, and home heating oil.

These future costs are in addition to current compliance expenditures and the cost of recently promulgated requirements. Summing all three of these sources of environmental compliance costs, a hypothetical 100,000 b/d refinery could face compliance costs of $59.0 million to $68.8 million per year on an annualized basis. This is a substantial level of costs, and does not include the cost of RFG Phase II or other future requirements (such as wastewater or other areas where costs were not developed). Costs at this level could potentially affect the ability of domestic refiners to compete with imports and meet the demand needs of U.S. consumers.

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[20] Comparison is made with the $5.7 billion spent by the refining industry in 1995, as reported in: American Petroleum Institute, *Petroleum Industry Environmental Performance, Fifth Annual Report*, May 1997.

[21] R.J. Beck, "U.S. Companies' Capital Outlays to Hit Highest Level Since 1991," *Oil & Gas Journal*, February 17, 1997.

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Table 2
Incremental Compliance Costs for a Hypothetical 100,000 b/d Refinery[1]
Million 1995 Dollars

Initiative	Without Considering Technology Overlap[2]			Considering Overlap of Technologies[2]		
	Capital Cost	Annual Cost	Annualized[3] Cost	Capital Cost	Annual Cost	Annualized[3] Cost
Hazardous Waste Listing	0	0 - 2	0 - 2	0	0.2	0.2
Compliance Assurance Monitoring (CAM)	1 - 3	0.1 - 0.2	0.3 - 0.5	1 - 3	0.1 - 0.2	0.3 - 0.5
Refinery MACTII	15 - 18	0.1 - 0.5	2 - 3	15 - 18	0.1 - .05	2 - 3
Industrial Combustion Combined Rule (ICCR)	8 - 17	1 - 4	2 - 6	8 - 17	1 - 4	2 - 6
SO_2 Short Term Peak Levels State Implementation	15[4]	3[4]	5[4]	NA[4]	2[4]	2[4]
Ozone NAAQS	15[4]	3[4]	5[4]	5[4]	2[4]	2 - 3[4]
Particulate Matter NAAQS	15[4]	3[4]	5[4]	NA[4]	2[4]	2[4]
Release Prevention Barriers on Above Ground Storage Tanks	18 - 49[5]	NA[6]	2 - 6[5]	18 - 49[5]	NA[6]	2 - 6[5]
Total All Initiatives	87 - 117	10 - 14	21 - 30	47 - 92	7 - 11	13 - 23

[1]Refinery Description:
- Crude capacity – 100,000 b/d
- Catalytic cracking capacity – 48,000 b/d
- Catalytic reforming capacity – 25,000 b/d
- Catalytic hydrocracking capacity – 30,000 b/d
- Catalytic hydrorefining capacity – 8,500 b/d
- Catalytic hydrotreating capacity – 28,000 b/d
- Sulfur recovery unit

This characterization is based on the average size of each unit among U.S. refineries that have each type of process unit.

[2]Since several rules are still being developed, the exact requirements for compliance are not known. This analysis has used existing technologies as surrogates for possible future technologies. Costs for several of the rulemakings have been estimated using the same or very similar technologies. The first set of columns shows the potential cost of each individual rulemaking based on the assumptions in this analysis. The second set of columns accounts for the use of the same or similar technologies and avoids double-counting. This is a function solely of the assumptions used, not due to an expectation that the rules will actually be overlapping. The second, more conservative total was used in the economic analysis.

[3]Annualized using 15 year life and 10% interest rate for a capital recovery factor of 0.13.

[4]Costs for these rulemakings were developed using the same or similar technologies as other regulations. See Appendix E for a complete discussion of how potential overlap has been avoided for the cumulative cost analysis. Appendix F estimates the full cost that could potentially be associated with these rulemakings.

[5]The wide range is attributable to the 2 extremes examined in the study on which this analysis is based.

[6]Annual costs were not estimated.

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E. Economic Impact on Refining Industry

To analyze the effects that substantial future compliance costs could have on the domestic refining industry, costs were input to a model of the world refining industry. The WORLD model, developed for the U.S. Department of Energy and recently modified for the Energy Information Administration, was used for this analysis. WORLD provides an integrated simulation of the global petroleum supply industry, capturing in a single analytical framework: worldwide crudes and non-crudes supply; regional refining operations, debottlenecking/revamping and investment in new capacity; regional petroleum product demand, with detailed product specifications, inter-regional movements (pipeline and marine) of crude oils, intermediate, and finished products; and refining and market economics. This linear programming model has been extensively used by the government in analyzing petroleum markets. Additional description of the WORLD model and the analysis performed is provided in Appendix H.

In performing this analysis, the process unit affected by the costs was considered to appropriately account for future capacity additions. Since the greatest level of additional costs applied either to the catalytic cracking unit or to the refinery in general (items like release prevention barriers on storage tanks), costs were simplified to two categories: added costs on the FCC and added costs on the crude unit. Added costs were considered separately by region in the United States (using Petroleum Allocation for Defense Districts (PADDs)). In the version of the WORLD model used for this analysis, Canadian refining capacity was combined with U.S. regions. Adjustments to capacity and investments were made to arrive at a U.S.-only basis. Although the future requirements considered in this analysis will take effect in different years, for purposes of this analysis, all were assumed to be implemented in 2002.

To account for the uncertainty associated with future requirements, costs for many of the initiatives considered were developed as a range. To avoid the confusion associated with applying a range of costs in a linear programming model, a single cost estimate for each initiative was used for modeling purposes. Where three cost scenarios were developed, the middle scenario was assumed in the model. Where only a high and low cost range were developed, the average of these costs was assumed. Costs were highest (on a per barrel basis) in PADD 4, which has the smallest refineries, and lowest in PADD 5, where the stringency of existing regulations reduces future costs.

In addition to the direct impact of higher costs, three types of indirect impacts are possible. These include: 1) a reduced ability to invest, since compliance expenditures reduce capital available; 2) lower refinery margins and profitability; and 3) potential reluctance to invest because of uncertainties over cost recovery. For this analysis, these indirect impacts are addressed by increasing the hurdle rate for investments.

Since WORLD simulations reflect refineries worldwide, it was necessary to make an assumption about the level of future environmental compliance costs that refineries outside the U.S. might face. Based on an analysis of recent articles in the trade press, it was assumed that refineries in Western Europe may face environmental costs growing at about half the rate in the United States. Refineries in other parts of the world are likely to experience much slower growth in future environmental compliance costs. Therefore, for this analysis, it was assumed that compliance costs outside the U.S. are equal to 25% of the costs developed in this analysis.

Oil prices, refined product prices, demand, and supply baseline assumptions were taken from the Energy Information Administration's 1997 *Annual Energy Outlook*. For the year 2002, EIA assumes a world oil price of $18.81/bbl (1995 dollars). EIA is projecting substantial demand growth — a global increase of 11.2 million bbl/d by 2002. This demand growth will necessitate significant new process capacity additions and investment. This provides an ideal situation for analyzing the impact of new environmental compliance costs on capacity additions and debottlenecking.

This analysis was performed by running four simulations. The first provides a base case look at the global refining industry without added compliance costs. This simulation allowed debottlenecking/ revamp investments to the following major units: crude atmospheric and vacuum distillation, catalytic

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cracking, and coking. The level of debottlenecking capacity additions was limited to the equivalent of 0.3% per annum net capacity "creep" addition.[22] The second simulation (Direct cost impact case) adds in the direct effect of the incremental environmental compliance costs. The third and fourth simulations are variations to include the indirect impact of additional compliance costs, in terms of their effect on a U.S. refiner's willingness or ability to invest in major new units. The latter accounts for the decrease in the "capital pool" for discretionary investments and lower refinery margins by increasing the hurdle rate for new projects — from 15% in the base case to 20% and 25% in these simulations (Direct and indirect case). The results of simulations two through four can be compared with the base case to determine the impact of the added costs. Table 3 presents the key results from these simulations.

Table 3
Summary of Economic Impacts Due to Increased Environmental Compliance Costs
Total to 2002

	Base Case	Direct Cost Case	Direct and Indirect Case (20%)	Direct and Indirect Case (25%)
Assumptions:				
Compliance costs	No	Yes	Yes	Yes
Cost of capital	15%	15%	20%	25%
Distillation capacity additions beyond debottlenecking — Million bbl/day:				
U.S.	0.373	0.163	0	0
Non-U.S. regions[1]	12.060	12.243	12.380	12.384
Major unit investments — $ Billion				
U.S.	22.1	21.5	15.2	10.5
Non-U.S. regions[1]	122.0	123.2	129.9	136.6
U.S. loss from base case		0.6	6.9	11.6
Refinery production — Million bbl/day				
U.S.				
PADD 1	1.884	1.876	1.832	1.809
PADD 2-4	10.862	10.758	10.529	10.438
PADD 5	3.348	3.263	3.322	3.365
Total	16.094	15.897	15.683	15.612
Non-U.S. regions[1]	50.335	50.554	50.748	50.819
U.S. loss from base case		0.197	0.411	0.482
Product net imports — Million bbl/day				
U.S.	1.698	1.920	2.143	2.211
Increase from base case[2]		0.222	0.445	0.513

1 Non-U.S. regions include all world regions except China, the former Soviet Union, and Eastern Europe. In this version of the WORLD model, these areas are represented in terms on net imports/exports only.
2 Changes in net imports do not exactly match changes in refinery production because Canada was subtracted from refinery production but not from net imports. Most Canadian product trade is with the U.S., with minor amounts to other regions.

[22] This rate was selected because it corresponds to the level of net capacity additions to U.S. refineries over the past 10 years, as discussed in "Oil Industry Restructuring," a paper by Marianne S. Kah, at the 24th ICEED Conference, Boulder, CO, April 1997.

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Base Case Results. In the base case, debottlenecking capacity increases took place up to their allowed limits for essentially all allowed units in virtually all world regions. This result was expected to meet the baseline projection of global product demand. For the U.S., net debottlenecking capacity additions were:

- Atmospheric distillation 360,000 b/d
- Vacuum distillation 173,000 b/d
- Coking 39,000 b/d
- Catalytic cracking 100,000 b/d.

A total of $22.1 billion was invested in new process units, concentrated mostly on upgrading (coking), desulfurization, hydrogen, and sulfur recovery. No investments beyond debottlenecking were, however, incurred on crude distillation or on catalytic cracking units.[23] This result is consistent with the pattern of U.S. refining investments over the past several years. Product prices and imports in the base case are those projected by EIA in its 1997 *Annual Energy Outlook*.

Direct Cost Case. The addition of substantial environmental compliance costs for U.S. refiners in the next five years reduces investments in new/revamped capacity, to the benefit of foreign refiners who are able to increase their imports to the United States. Since capital that would otherwise be spent in adding capacity is siphoned off for environmental compliance, distillation capacity additions decline 210,000 b/d from the base case. But investments are still being made; investments in new capacity do not fall by the full amount of the increased environmental costs. Debottlenecking activities, often the first funded from the capital budget, continue at close to the level observed in the base case.

A global rebalancing of operations and economics would occur to adapt to the higher costs faced by U.S. refiners. Decreased investment means that U.S. refiners cannot meet the increased demand for refined products in the U.S., so product imports increase by over 220,000 b/d. Worldwide, product prices increase by $0.06 to $0.10 per barrel by 2002, allowing U.S. refiners to recoup a portion of their compliance investments. But the portion that could not be recovered would reduce refinery margins. If this situation continued, U.S. refiners could become more reluctant to make discretionary investments, since their possible return would be lower.

The combination of reduced investment in the U.S. and lower margins could have implications for refinery closures. Smaller refineries could elect to close rather than make massive compliance expenditures that could not be recouped. This would result in job loss for the employees at those refineries. If other refineries were not adding new capacity, new jobs would not be created to replace those lost in the refineries that closed. While it is difficult to quantify the number of jobs lost, this is a likely outcome of the level of addition environmental compliance costs projected. Federal, state, and local governments would also lose tax revenues.

Direct and Indirect Case. In addition to the direct environmental expenditures, this case incorporates the indirect effect of a higher hurdle rate, which is probably a realistic expectation. A higher hurdle rate for discretionary investments results in a curtailment of capacity additions beyond debottlenecking. Debottlenecking activities still occur, but at a slightly lower rate than in the base case. Total refinery investment in capacity is $6.9 billion to $11.6 billion lower than in the base case. At a 25% hurdle rate, this translates to almost a dollar for dollar reduction in investment for the mandated compliance cost expenditures. Capacity to meet demand is affected in all regions of the U.S., but the largest reductions occur in PADDs 2, 3, and 4.

The reduction in investment in the U.S. is compensated for outside the U.S., positioning foreign refiners to take a larger share of the U.S. market. Refined product imports are projected to rise by as much as 500,000 b/d as U.S. refiners are unable to meet domestic product demand. This increases U.S. import dependency, an effect that could have national security implications.

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[23] No distillation capacity additions were allowed in PADD 1.

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As upgrading investments in the U.S. are reduced, crude and product prices are affected, with light-heavy differentials increasing. On the U.S. Gulf Coast, prices for medium sour crudes, such as Isthmus and Arab Light are generally unchanged, but light sweet crudes, such as North Sea and West Texas Intermediate, increase by up to $0.50/bbl. Prices for heavy sour crudes, such as Mayan, decline by up to $1/bbl, since the market for these crudes is smaller than it would be had additional upgrading investments been made. Product prices are similarly affected. U.S. Gulf Coast prices for light products (gasoline, heating oil) increase by $0.50/bbl to $0.75/bbl, while products like high sulfur (3%) residual fuel oil fall by more than $1/bbl. As consumers increase their demand for light products (in part a by-product of environmental concerns), upgrading capacity becomes more important. A lack of investment in upgrading capacity in the U.S. could make it even more difficult to meet consumer demand.

Summary. The need to comply with the environmental initiatives discussed in this analysis may:

- Reduce U.S. refinery margins
- Transfer capital from productive process unit capacity additions into environmental compliance expenditures
- Reduce the level of long term investment over and above debottlenecking
- Shift refining investments from the U.S. to other world regions
- Cut U.S. refinery throughputs, possibly by up to 500,000 b/d, with implications for refinery closures, associated job losses, and tax revenue loss by governments
- Increase product import dependency
- Increase world crude oil and refined product prices, including consumer prices in the United States.

Impacts of this nature have serious implications for the health of the domestic refining industry. A strong and healthy refining industry is important to the U.S. economy. If regulations are more stringent than is needed to protect human health and the environment, these impacts will be felt unnecessarily. Rulemaking and legislative activities should consider these possible effects.

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V. FUTURE REQUIREMENTS ON TRANSPORTATION AND MARKETING INDUSTRY

The petroleum transportation and marketing industry has recently been the subject of numerous regulations. Many of these had phased compliance periods, and companies are still making the substantial investments involved in compliance. In addition, bulk terminals and pipelines could face several new environmental compliance requirements.

Terminals and pipelines are still working to comply with the gasoline distribution NESHAP, which was designed to control air emissions associated with the storage, transportation, loading, and unloading (of tanks, barges, etc.) of gasoline. This rulemaking, promulgated December 1994 and allowing 3 years for compliance, provides for floating roofs and rim seals on storage tanks, a 10 milligram per liter limit on total organic compound (TOC) emissions from loading/unloading operations, visual inspection for leaks, and annual pressure tests and certification tests for tank trucks and railcars. According to EPA, this rulemaking was expected to cost terminals, cargo vessels, and pipeline breakout stations a total of $18 million/year.

In the discussion of refining issues above, it was noted that one recent addition to costs was the marine terminals MACT. This rulemaking was designed to control emissions during the loading and unloading of petroleum products at marine terminals, requiring that vapors be captured and either recovered or combusted. A portion of these marine terminals are located at refineries, but the remainder fall within the bulk storage/terminal sector. Consistent with the above assumptions about the portion of marine terminals at refineries, this rulemaking, for which compliance is currently in process, is expected to cost other terminals a total of $199.5 million and $330 million in capital cost and $45 million to $75 million in annual operating cost.

One of the largest requirements still facing marketing facilities (especially gasoline stations) has to do with underground storage tanks. Underground storage tanks are required to be upgraded or replaced to prevent leaks. Although this requirement was promulgated in 1988, a 10 year time frame was provided for compliance to minimize the burden. While many facilities have already made the necessary investments, for others the 1998 deadline is looming large. Given the portion of facilities that have already complied, the costs for this requirement have not been considered in this analysis (already in current costs for many facilities). Nonetheless, it is important to note that many facilities still face compliance costs for the improvements required by 1998.

Several pending requirements could add to the compliance cost for this industry sector, potentially including:

Bulk Storage/Terminals

- Expansion of the Toxic Release Inventory
- Release prevention barriers on storage tanks.

Liquids Pipelines

- Release prevention barriers on storage tanks
- Spill prevention and pipeline integrity measures in areas defined as being unusually sensitive to environmental damage (intelligent pigging, hydrostatic testing, emergency flow restriction devices, leak detection requirements, additional inspection requirements)

Each of these potential requirements is discussed in more detail below.

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A. Description of Future Requirements

Because this analysis focuses on regulations that have not yet been promulgated, assumptions about the likely requirements that may be imposed are necessary. This analysis has attempted to avoid a "worst-case" characterization of the future. Although there is a degree of uncertainty associated with the projected requirements, the costs estimated are believed to represent a realistic view of the costs of compliance with these future regulatory requirements.

Each of the future requirements considered in this analysis is described below. The costs of these future requirements are summed in the following section. It should be noted that the regulations listed below are only those currently under development. Additional requirements are sure to be added in the future, increasing compliance costs. It should also be noted that the future requirements considered include only incremental controls (e.g., to prevent spills) and reporting requirements. Health and safety requirements on the industry have not been considered in this analysis.

Expansion of the Toxic Release Inventory. Section 313 of the Emergency Planning and Community Right to Know Act (EPCRA), also known as Title III of the Superfund Amendments and Reauthorization Act (SARA) requires certain facilities to file annual reports to the U.S. Environmental Protection Agency and States on their releases and transfers of certain toxic chemicals of they exceed specific thresholds. The statute applies the requirements of EPCRA Section 313 only to manufacturing industries, but gave EPA the authority to modify the list of industries subject to reporting. Currently refineries are the only sector of the oil and gas industry that are required to report. However, on June 27, 1996 (61 FR 33587) EPA announced plans to expand reporting requirements to certain non-manufacturing industries, including petroleum bulk storage terminals (SIC 5171). This rulemaking was delayed, in part due to concerns over the impact of the expansion to small businesses in certain sectors (including bulk terminals), but was finalized on May 1, 1997.

Bulk storage terminals will have to report releases of any listed TRI chemicals beginning January 1, 1998. Only facilities with 10 or more full-time equivalent employees (FTEs) would be required to report. Based on data from the Bureau of the Census, 3,863 bulk terminals (around 38% of terminals) are estimated to exceed the 10 FTE threshold that would trigger compliance. But all terminals will need to collect enough data to perform a reasonable assessment of whether they exceed the threshold and reporting is required. All affected facilities would be required to complete a Form R for every TRI chemical that is handled at the facility in excess of certain thresholds. The cost of compliance includes compliance determination, rule familiarization, calculations and report completion (form R and certification statement), and mailing and recordkeeping.

In its analysis of the proposed rulemaking, EPA estimated that, on average, bulk storage terminals would be required to submit reports for 8 chemicals that exceeded threshold reporting levels. In an analysis included in its comments on the proposed TRI industry expansion, API estimated that bulk storage facilities would each need to file between 10 and 21 Form R reports.[24] API's estimate is based on the inclusion of some products present at these facilities that were excluded by EPA, along with a finding that more reportable chemicals are present in certain petroleum products. The range found by API has been used for this analysis.

Release prevention barriers on storage tanks. As with refineries, bulk terminals and pipelines could be affected by legislation, regulations, or "voluntary" programs to retrofit storage tanks with additional protective measures, including release prevention barriers [see discussion in refining section on possible requirements].

This analysis assumes that through either federal or state action, or as part of their participation in a voluntary program, pipelines and bulk terminals will retrofit their storage tanks with release prevention barriers. Based on an analysis previously conducted for API, a range of costs has been assumed which

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[24] API comments to EPA on TRI expansion to SIC 5171, prepared by The EOP Group, Inc., August 23, 1996.

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