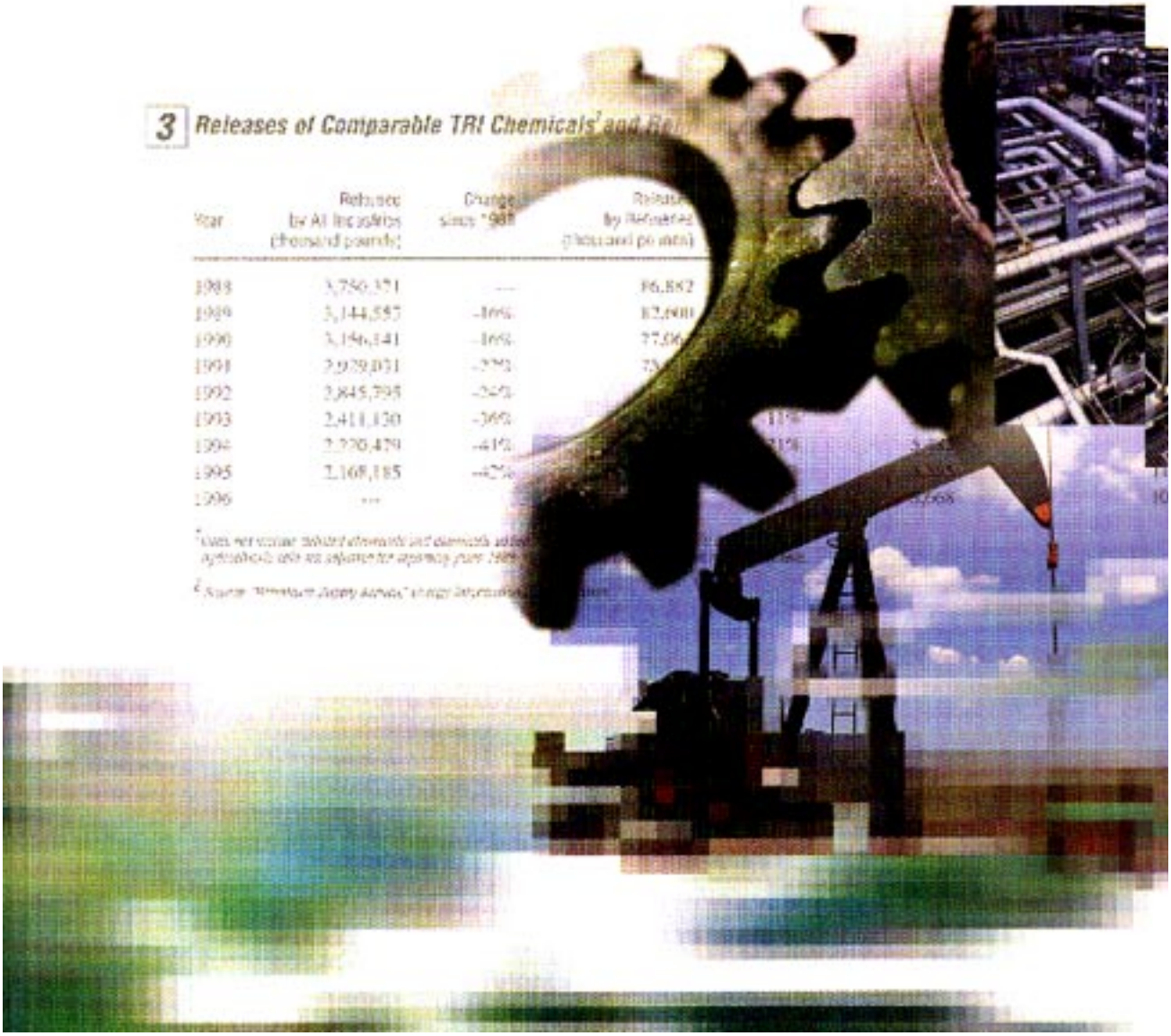
American Petroleum Institute

STEP

6th Annual Report

Petroleum Industry Environmental Performance



Contents

The long term viability of the petroleum industry and the many industries that rely on petroleum products depends on their compatibility with the nation's goal of improving the environment.

Message from API's President

This sixth annual report on the petroleum industry's environmental and safety performance tells the continuing story of our efforts to create a cleaner and safer environment. It's an important yardstick that the public, government and industry can use in measuring our progress in protecting the environment and our workers. It also provides perspective on where more work can be done.

The report is part of API's Strategies for Today's Environmental Partnership (STEP), the industry's shared commitment to continuous improvements in environmental, health and safety performance.

Factual data in eight areas of performance are highlighted. The data come from the U.S. Coast Guard, the U.S. Environmental Protection Agency, the U.S. Bureau of Labor Statistics and industry surveys. Our statisticians—both at API and within our member companies—carefully check to ensure data accuracy.

It is our hope that this type of report fosters increased communication and understanding between our industry and its many interested customers. America's oil and gas industry works hard at trying to improve the quality of life for each American through the products we provide safely, economically, conveniently, and in a manner that respects the environment.

Red Cavaney
May 1998

Environmental, Health and Safety Objectives, Mission and Guiding Principles

Objectives

STEP—Strategies for Today's Environmental Partnership—is the petroleum industry's shared vision and responsibility for achieving four objectives:

- Improving industry environmental, health and safety performance;
- Documenting performance improvements;
- Communicating these improvements; and
- Building sustained understanding and credibility through dialogue with interested or concerned groups and individuals.

Mission

The members of the American Petroleum Institute are dedicated to continuous efforts to improve the compatibility of our operations with the environment while economically developing energy resources and supplying high quality products and services to consumers. We recognize our responsibility to work with the public, the government, and others to develop and to use natural resources in an environmentally sound manner while protecting the health and safety of our employees and the public. To meet these responsibilities, API members pledge to manage our businesses according to the following principles using sound science to prioritize risks and to implement cost-effective management practices:

Guiding Principles

- To recognize and to respond to community concerns about our raw materials, products and operations.

- To operate our plants and facilities and to handle our raw materials and products in a manner that protects the environment and the safety and health of our employees and the public.

- To make safety, health and environmental considerations a priority in our planning, and our development of new products and processes.

- To advise promptly appropriate officials, employees, customers and the public of information on significant industry-related safety, health and environmental hazards, and to recommend protective measures.

- To counsel customers, transporters and others in the safe use, transportation and disposal of our raw materials, products and waste materials.

- To economically develop and produce natural resources and to conserve those resources by using energy efficiently.

- To extend knowledge by conducting or supporting research on the safety, health and environmental effects of our raw materials, products, processes and waste materials.

- To commit to reduce overall emission and waste generation.

- To work with others to resolve problems created by handling and disposal of hazardous substances from our operations.

- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.

- To promote these principles and practices by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of similar raw materials, petroleum products and wastes.

The petroleum industry is a vital component of the U.S. economy. It processes and transports 65 percent of the energy Americans consume. This includes vast quantities of transportation fuels, home heating oil, and industrial fuels, as well as petrochemicals used in the manufacture of countless consumer products. The industry also provides jobs for 1.4 million people.

The long term viability of the petroleum industry and the many industries that rely on petroleum products depends on their compatibility with the nation's goal of improving the environment. Like all Americans, the men and women who work in the petroleum industry want their community and work environments to be safe, clean and healthy.

This report, the sixth *Petroleum Industry Environmental Performance Annual Report*, presents statistical information about the industry's environmental or safety performance in eight areas. This introduction surveys some of the efforts the industry has made to help improve environmental quality and presents a summary of the report's key findings.

Improving Environmental Performance

The U.S. petroleum industry produces, transports, and refines billions of barrels of crude oil every year—then moves vast quantities of gasoline, diesel fuel and other refined products to distribution centers and retail outlets in every corner of the nation and beyond. Virtually all Americans consume these products, more of which are used every year. Yet, over the years, the environmental impact of the nation's reliance on oil has steadily lessened. Three reasons primarily account for this progress: government requirements the industry is implementing; continuously improved industry practices voluntarily adopted by companies; and industry research programs and improved technology.

Implementing Government Regulations

Industry facilities and products must meet strict federal, state and local government requirements. Refineries must limit pollutants discharged into the air or waterways. Oil drillers must treat wastes for safe disposition. Shippers and distributors of oil and oil products must ensure they minimize spills and emissions. And all must respond rapidly and effectively in case of spills or other types of accidents. To make the government rules it implements as practical and cost-effective as possible, the oil industry actively participates in their development.

A prime example of the impact of government regulations concerns fuels. In the past 25 years, the industry has produced six progressively cleaner-burning fuels required by the government, including lead-free gasoline and new reformulated gasolines.

According to the U.S. Environmental Protection Agency (EPA), the use of reformulated gasoline has had the equivalent effect of eliminating emissions from eight million cars nationally. According to the state of California, its special brand of reformulated gasoline had the effect of eliminating the emissions of 3.5 million vehicles in that state alone. Coupled with improved emission reduction equipment on cars, these cleaner fuels are reducing the impact of automobile pollution even though people are driving more.

The latest EPA figures on air quality improvements suggest that reduced emissions from gasoline- and diesel-powered highway vehicles are a primary factor in the steady progress that has been achieved. For example, between 1987 and 1996, emissions from highway vehicles declined 25 percent compared with a 12 percent decrease from all other sources. Since 1970, emissions from highway vehicles declined almost 40 percent even though the number of vehicle miles traveled increased by 121 percent.

Industry Standards and Other Voluntary Efforts

Industry standards and recommended practices also contribute to improved environmental, health and safety performance. Through its national trade association, the American Petroleum Institute (API), the industry produces and maintains about 500 voluntary standards, many of which are adopted worldwide and often incorporated in government regulations.

These include, for example, standards for pipeline safety that cover pipeline installation, monitoring, corrosion control, and damage prevention. They include standards that focus on the safety and integrity of aboveground

and underground tanks relating to construction materials, testing methods, installation, leak detection, spill prevention, and soil and groundwater remediation. And, they include API standards that improve personnel safety and reduce environmental risks associated with offshore drilling and production. These standards helped API win the National Ocean Industries Association's "Safety in Seas" award in 1994. Industry has continued to work with federal agencies to measure the implementation of these voluntary programs.

In addition, API's in-service inspection codes help maintain the safe operation of critical refinery process equipment such as aboveground storage tanks, pressure vessels, piping, heaters, boilers, and pressure-relieving devices. To ensure that these inspection codes are applied by qualified personnel, the industry, through API, also organizes training programs on their proper implementation—and certifies inspectors. For example, API has certified some 2,500 inspectors of aboveground storage tanks, pressure vessels, and process piping.

Apart from implementing industry standards and recommended practices, individual companies constantly upgrade equipment and procedures in ways that enhance environmental performance and worker safety. For example, many refiners have their own inspection and training programs in place that both reduce risks and improve productivity.

Research and Technology

Finally, through research and technology development, the industry is also working to improve the environment. On the technology front, CT scans and magnetic resonance imaging—the same technology that reveals the interior structures of the human body—are used with three-dimensional surveys and satellite imaging to find and map subterranean oil and gas fields. These limit the number of wells needed, reducing potential environmental impacts. Horizontal wells make it possible to drill parallel to the Earth's crust, also reducing the number of wells. Slimmer wells—only four inches in diameter—can now be drilled, producing less waste. And, ultrasonic and electromagnetic devices detect thin spots in storage tanks and pipelines, allowing repairs to be made before leaks occur.

Industry research programs also help make petroleum operations and products cleaner and healthier. Scientists are researching better methods to reduce the impacts of petroleum operations and products on ground and surface water; they are looking at the nature and behavior of air pollution, including potential human exposure; and they are exploring potential health impacts of petroleum products and product constituents and ways to minimize them. A $40 million study, by 14 oil companies and three domestic automakers, helped point the way to the most cost-effective methods of reducing automobile emissions.

Measuring Environmental Progress

The information in this report was gathered from the U.S. government and from oil companies responding to API surveys. Here are the report's principal findings, the details of which appear in the chapters following:

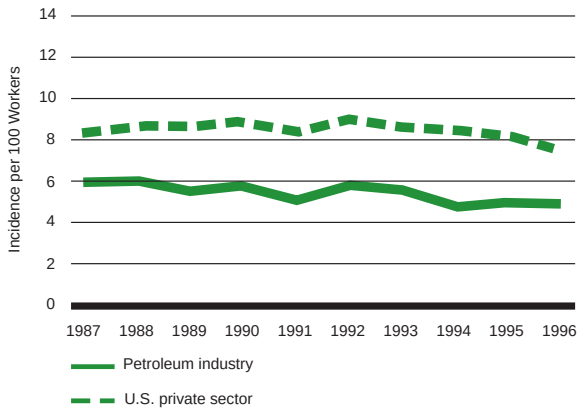
Improving Workplace Safety

Between 1987 and 1996, the overall rate of job-related injuries and illnesses in the U.S. petroleum industry per 100 full-time workers declined 19 percent compared with an 11 percent decrease for the entire U.S. private sector.

The rates for the petroleum industry remained substantially below those for the private sector over the 10-year period.

In 1996, the job-related injury and illness rates for the refining and exploration and production sectors were the lowest since 1972.

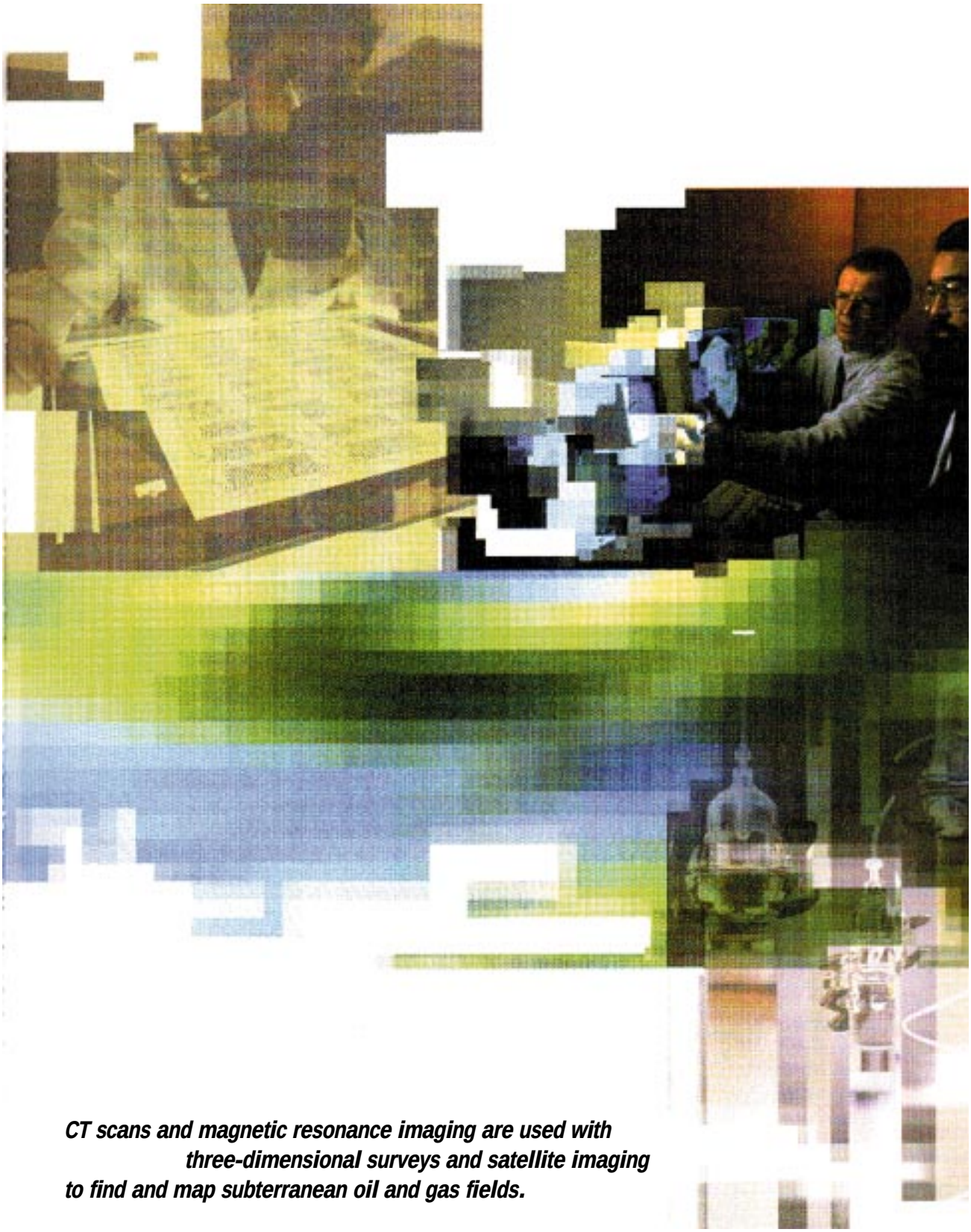
Petroleum Industry and U.S. Private Sector



Managing Chemicals in Refinery Wastes

Releases of chemicals monitored under EPA's Toxics Release Inventory (TRI) program decreased by 10 percent from 1995 to 1996 and 32 percent since 1988. (This includes chemicals continuously tracked by EPA, not those added or delisted after 1988.)

Releases of TRI chemicals classified as carcinogens declined by 24 percent from 1995 to 1996 and 53 percent since 1988.

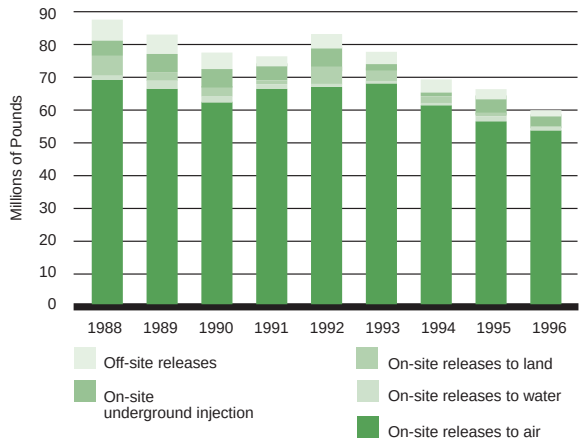


CT scans and magnetic resonance imaging are used with three-dimensional surveys and satellite imaging to find and map subterranean oil and gas fields.

Of the 2.6 billion pounds of TRI chemicals managed in refinery waste in 1996, 71 percent were treated to reduce volume or toxicity prior to disposal; 16 percent were burned for energy recovery; and 10 percent were recycled. Only 3 percent were released to the environment.

Refinery Releases of TRI Chemicals by Medium

Releases of comparable TRI chemicals decreased by 32 percent since 1988. Releases to the air, which constitute the majority, declined by 23 percent since 1988.

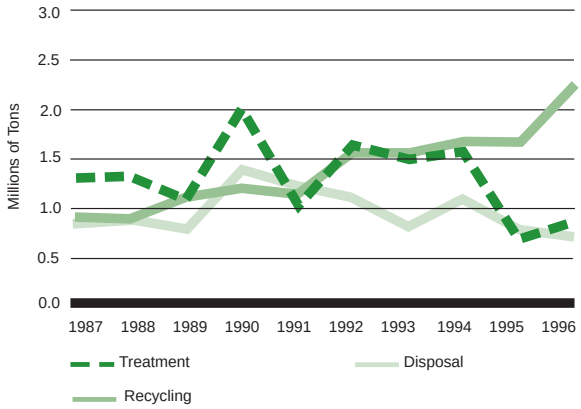


Managing Refinery Residuals

U.S. refineries have made significant progress in increasing the portion of residuals recycled and reducing the portions that are treated and disposed. In 1987, when API began conducting its survey, refineries recycled 28 percent of their residuals, treated 44 percent and disposed of the remaining 28 percent. In 1996, refineries recycled 60 percent of their residuals, treated 22 percent, and disposed of the remaining 18 percent. The quantity recycled increased to 2.2 million tons in 1996—an increase of 173 percent since 1987.

Residuals Management: Methods and Amounts

Since 1992, refineries have recycled more residual materials than they have discarded.



Reducing Oil Spills in U.S. Waters

The number of oil spills was down by more than 900 in 1996. To put the total amount spilled into perspective, it was about one-thousandth of one percent (0.001 percent) of the 281 billion gallons of oil consumed by Americans during the year.

The number of large spills (those over 10,000 gallons) in 1996 was the third lowest annual total recorded over the ten-year period covered by the report.

More than three-fourths of all spills reported were less than 10 gallons.

Improving Underground Storage Tanks

At the end of July 1997, more than 85 percent of tanks reported in an API survey already met December 1998 federal safeguards for preventing overfilling and spilling.

Some 83 percent of the tanks already met December 1998 federal standards for preventing corrosion.

API members regularly check all tanks for leaks, and more than 60 percent already met the December 1998 federal standards for detecting leaks.

Recycling Used Motor Oil

API companies and their independent dealers responding to API's survey collected some 24.1 million gallons of used motor oil in 1996.

API members operated almost 12,200 drop-off used oil centers in 1996.

Since 1991, companies and their dealers have collected nearly 81 million gallons of used motor oil in 47 states and the District of Columbia.

Reducing Emissions of Gasoline Vapors

Of the more than 19,000 petroleum product storage and transfer facilities and service stations included in this API member survey, all met or exceeded federal requirements to control gasoline vapor emissions.

Investing in a Cleaner Environment

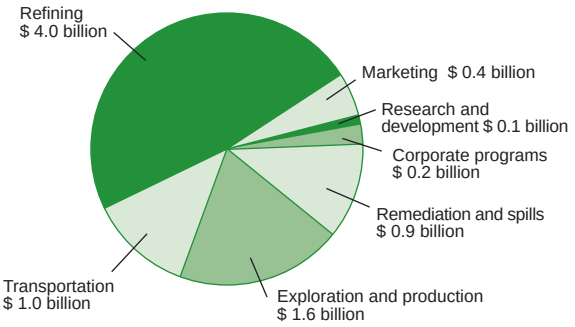
The petroleum industry spent about $8.2 billion on the environment in 1996. This was about one-fourth the net income of the top 200 oil and natural gas companies and more than EPA's entire budget. The expenditures break down to $83 per U.S. household.

Operational, maintenance and administrative expenditures steadily increased since 1993 to a record high of $5 billion in 1996. Capital expenditures were highest between 1992 and 1994 due to investments in new equipment and processes needed to manufacture cleaner burning fuels required by the federal government and the state of California. They decreased to $2 billion in 1996. This trend may be reversed in the future as a result of additional environmental regulations proposed.

Most spending in 1996 on environmental improvements was in the refining sector.

Total U.S. Environmental Expenditures: 1996

The industry spent about $8.2 billion to protect the environment.



This section compares the rates of job-related injuries and illnesses in different parts of the U.S. petroleum industry with those in the U.S. private sector. It is based on information from the U.S. Bureau of Labor Statistics (BLS) publication, *Occupational Injuries and Illnesses: Counts, Rates and Characteristics.*

The U.S. Occupational Safety and Health Administration (OSHA), part of the Department of Labor, requires employers to keep records of job-related injuries that result in death, loss of consciousness, days of lost or restricted work, transfers to different jobs or medical treatment beyond first aid. Employers must also report job-related illnesses (i.e., abnormal conditions or disorders). BLS, another part of the Department of Labor, uses these records to create a statistical profile of each industry.

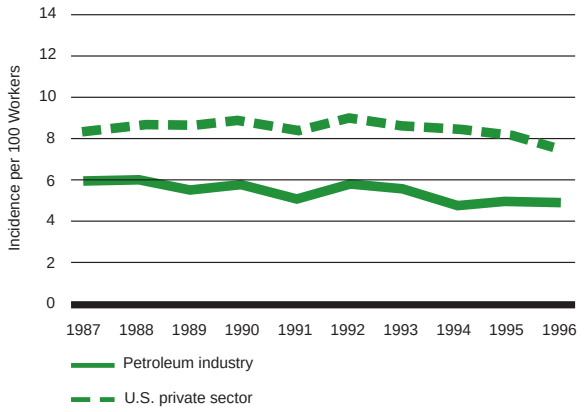
Each year, BLS surveys a representative sample of companies throughout the United States. In compiling the results, BLS adjusts for those who fail to respond to ensure that the data accurately represent each industry. The survey is limited to private industry. It includes contract workers, but not self-employed people, farms that employ fewer than 11 people, household workers, and government employees.

OSHA and the petroleum industry continue to strive to reduce the number of injuries and illnesses. OSHA Process Safety Management regulations cite a number of API standards that address fire protection and workplace safety. These include area classification criteria for electrical installations; protection from static, lightning and stray currents; and the management of process hazards.

Results

Between 1987 and 1996, the overall number of job-related injuries and illnesses in the U.S. petroleum industry per 100 full-time workers declined 19 percent—from 5.9 to 4.8. The U.S. private sector rate decreased 11 percent over the same ten years—from 8.3 to 7.4. The rates for the petroleum industry remained substantially below the rates for the private sector over the entire period.

Figure 1. Petroleum Industry and U.S. Private Sector



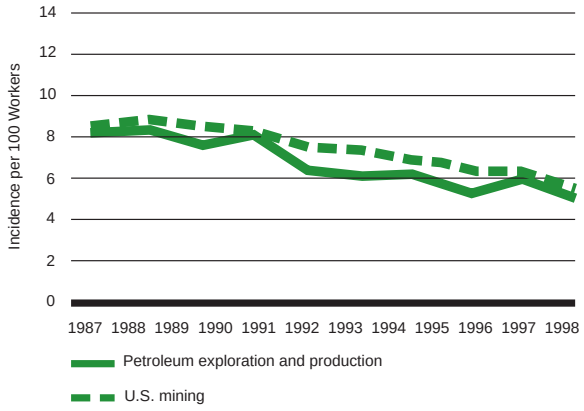
On average, the rate of injuries and illnesses in the U.S. petroleum industry from 1992 to 1996 was about 9 percent less than the average rate from 1987 to 1991. For the entire U.S. private sector, the decline between the two periods was about 3 percent.

The following sections compare specific petroleum industry rates with those of other comparable industries:

Exploration and Production

In 1996, the number of job-related injuries and illnesses per 100 full-time U.S. petroleum exploration and production workers dropped 15 percent to 5.0—its lowest level since 1972. For comparison, in 1996, the rate per 100 full-time U.S. miners fell 13 percent to 5.4. Between 1987 and 1996, the rate for petroleum exploration and production workers dropped 40 percent while the rate for miners declined 36 percent (see Figure 2).

Figure 2. Petroleum Exploration and Production and U.S. Mining

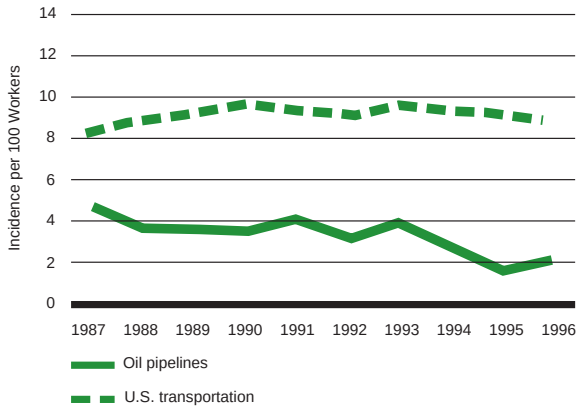


On average, the rate of injuries and illnesses among exploration and production workers from 1992 to 1996 was 26 percent less than the average rate from 1987 to 1991. For workers in mining industries, the decline between the two periods was 23 percent.

Transportation

Between 1987 and 1996, the number of job-related injuries and illnesses per 100 full-time U.S. oil pipeline workers declined 57 percent to 2.0. The rate in 1996 was less than one-fourth the rate of all U.S. transportation workers, which recorded an overall increase in job-related injuries and illnesses of 4 percent over the ten-year period. While the rate for oil pipeline workers increased from 1.6 to 2.0 between 1995 and 1996, it still represented the lowest injury and illness rate of all parts of the petroleum industry (see Figure 3).

Figure 3. Oil Pipelines and U.S. Transportation

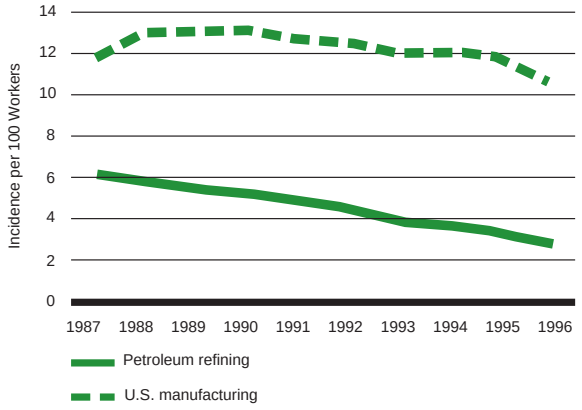


On average, the rate of injuries and illnesses among oil pipeline workers from 1992 to 1996 was 32 percent less than the average rate from 1987 to 1991. For all transportation workers, the average rate of injuries and illnesses increased by 1 percent between these two periods.

Refining

The rate of job-related injuries and illnesses in U.S. refining is four times lower than the overall rate among U.S. manufacturing facilities, and is declining at a significantly greater rate. From 1995 to 1996, the number of job-related injuries and illnesses per 100 full-time U.S. refinery workers dropped 13 percent to 2.8—the lowest since 1972. This is approximately one-fourth the injury and illness rate of all U.S. manufacturing workers, which declined 9 percent in 1996. Between 1987 and 1996, the rate for refinery workers declined by 55 percent, compared with a decrease of 11 percent for all manufacturing workers (see Figure 4).

Figure 4. Petroleum Refining and U.S. Manufacturing

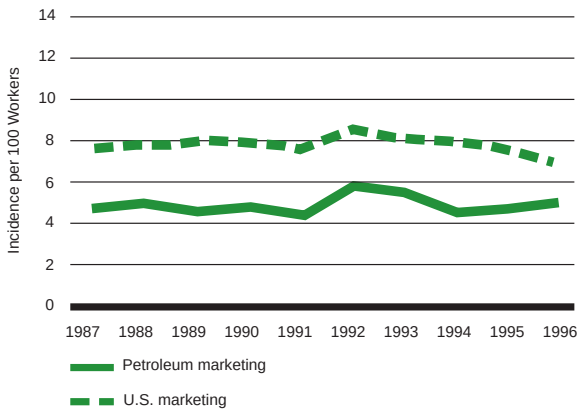


Marketing

In 1996, the rate of job-related injuries and illnesses among 100 full-time U.S. petroleum marketing personnel was more than one-fourth less than the rate for all U.S. marketing workers—even though it increased 5 percent while the rate for all marketing workers declined by 9 percent. Between 1987 and 1996, the rate for petroleum marketing personnel increased 7 percent while the rate for all marketing personnel decreased 12 percent (see Figure 5). The rate of job-related injuries and illnesses among 100 full-time petroleum wholesale marketing personnel was the lowest since 1985.

On average, the rate of injuries and illnesses among petroleum industry marketing workers from 1992 to 1996 was 10 percent more than the average rate from 1987 to 1991. For all private sector marketing workers, the average rate declined by 1 percent between these two periods.

Figure 5. Petroleum Marketing and U.S. Marketing



Definitions

Full-time worker: For purposes of this report, the equivalent of someone who works 40 hours per week for 50 weeks a year or 2,000 hours per year. Thus, two people working 1,000 hours apiece count as one full-time worker.

Illness: An abnormal condition or disorder, other than one resulting from an occupational injury, caused by exposure to environmental factors associated with employment. It includes acute and chronic illnesses or diseases that may be caused by inhalation, absorption, ingestion or direct contact.

Injury: A single, instantaneous event in the workplace that results in a fracture, cut, abrasion, burn, bruise, loss of consciousness or other damage to the body. Back ailments are an exception in that they are classified as injuries even if not caused by a single event.

Technical Notes

According to BLS, the margins of error were 16 percent for exploration and production, 140 percent for oil pipelines, 14 percent for refining, 18 percent for retail marketing, and 42 percent for wholesale marketing. BLS does not provide margins of error for all marketing or for the petroleum industry as a whole.

For example, the incidence rate of 5.2 for retail marketing has an estimated margin of error of 18 percent. In other words, BLS is 95-percent confident that the interval between 4.26 and 6.14 (or 5.2 plus or minus (5.2 x 0.18)) includes the true incidence rate for petroleum retail marketing. In the case of oil pipelines, the incidence rate of 2.0 for oil pipelines has an estimated margin of error of 140 percent. In other words, BLS is 95-percent confident that the interval between 0 and 4.8 (or 2.0 plus or minus (2.0 x 1.4)) includes the true incidence rate for oil pipelines.

The margins of error for comparable U.S. industries range between 2 percent (for the entire private sector) and 8 percent (for mining).

In 1992, the Bureau of Labor Statistics stopped including fatalities in the statistics used in this report. Because fatalities were rare, the change had little—if any—effect on overall illness and injury rates.

Because the margins of error for some of the petroleum industry's estimated rates are relatively high, the last row of Tables 1 and 2 was added to represent the percent change between the first half and the second half of the decade covered by this report. This measure is more statistically robust than changes between individual years.

Table Notes

Percent changes are based on exact averages and, in some cases, may not agree with the rounded averages shown in the tables.

1997 Winners of API Pipeline Safety Awards

API annually presents pipeline safety awards to liquid petroleum pipeline companies that achieve certain high performance levels. Three categories of awards are given—one to companies with the best safety records, one to companies with the most improved safety records, and one to companies that report no lost workdays.

The winners are determined based on an API annual survey, the results of which are published in the *Summary of U.S. Occupational Injuries, Illnesses, and Fatalities in the Petroleum Industry.*

Best Safety Record

Awarded to companies with no lost workdays and the lowest incident rate in that company size category.

1-100 Employees
Anschutz Ranch East Pipeline Inc.
Butte Pipe Line Company
Central Florida Pipeline Corporation
CINIZA Pipe Line Company
Collins Pipeline Company
Cook Inlet Pipe Line Company
Enterprise Products Company
Oiltanking Houston Inc.
Olympic Pipe Line Company
Razorback Pipeline Company
Tellepsen Pipeline Services Company
Trans Mountain Oil Pipe Line
United Refining Company
Wyoming Pipeline Company

101-500 Employees
CITGO Petroleum Corporation
CITGO Pipeline Company
Explorer Pipeline Company

More than 500 Employees
CONOCO Inc.

Most Improved Safety Record

Awarded to companies with the biggest decrease from the previous year in incident rate.

1-100 Employees
Olympic Pipe Line Company

101-500 Employees
Explorer Pipeline Company

More Than 500 Employees
Buckeye Pipe Line Company

No Lost Workdays

Awarded to companies with no fatalities, no days away from work, and no days of restricted activity.

Anschutz Ranch East Pipeline Inc.
BP America Inc.
BP Oil Pipeline Company
Butte Pipe Line Company
B.W.O.C. Inc.
CITGO Petroleum Corporation
CITGO Pipeline Company
CALNEV Pipe Line Company
Cenex Pipeline Company
Central Florida Pipeline Corporation
CINIZA Pipe Line Company
Collins Pipeline Company
Colonial Pipeline Company
Cook Inlet Pipe Line Company
CONOCO Inc.
Dixie Pipeline Company
Enterprise Products Company
Explorer Pipeline Company
Fina Oil Chemical/Pipeline Company
LOOP LLC
Navajo Pipeline Company
Oiltanking Houston Inc.
Olympic Pipe Line Company
Plantation Pipe Line Company
Razorback Pipeline Company
Seagull Energy Corporation/Seagull Pipeline/Marketing
Tellepsen Pipeline Services Company
Trans Mountain Oil Pipe Line
Union Pacific Resources
United Refining Company/ Kiantone Pipeline Division
Wyoming Pipeline Company

1 Petroleum Industry Job-related Injuries and Illnesses: 1987-1996

(per 100 full-time workers)

Year	Exploration and Production	Oil Pipelines	Refining	Retail Marketing	Wholesale Marketing	All Marketing[1]	Entire U.S. Petroleum Industry[1]
1987	8.3	4.6	6.2	4.6	4.9	4.7	5.9
1988	8.3	3.6	5.8	4.7	5.7	4.9	6.0
1989	7.6	3.5	5.3	4.4	5.1	4.6	5.5
1990	8.0	3.4	5.1	4.5	5.4	4.7	5.7
1991	6.4	4.0	4.9	4.1	5.7	4.5	5.1
1992	6.0	3.1	4.5	5.9	5.6	5.8	5.7
1993	6.1	3.8	3.9	5.5	5.6	5.5	5.5
1994	5.4	2.4	3.6	4.6	4.7	4.6	4.7
1995	5.9	1.6	3.2	4.4	6.1	4.7	4.9
1996	5.0	2.0	2.8	5.2	4.2	5.0	4.8
% Change							
1995-96	-15%	25%	-13%	18%	-31%	5%	-2%
1987-96	-40%	-57%	-55%	13%	-14%	7%	-19%
1987-91 Average	7.7	3.8	5.5	4.5	5.4	4.7	5.6
1992-96 Average	5.7	2.6	3.6	5.1	5.2	5.1	5.1
% Change	-26%	-32%	-34%	15%	-2%	10%	-9%

[1] *Weighted average calculated by API using U.S. Bureau of Labor Statistics employment figures.*

2 Comparable U.S. Industries Job-related Injuries and Illnesses: 1987-1996

(per 100 full-time workers)

Year	Mining	Transportation	Manufacturing	Retail Marketing	Wholesale Marketing	All Marketing	Entire U.S. Private Sector
1987	8.5	8.4	11.9	7.8	7.4	7.7	8.3
1988	8.8	8.9	13.1	7.9	7.6	7.8	8.6
1989	8.5	9.2	13.1	8.1	7.7	8.0	8.6
1990	8.3	9.6	13.2	8.1	7.4	7.9	8.8
1991	7.4	9.3	12.7	7.7	7.2	7.6	8.4
1992	7.3	9.1	12.5	8.7	7.6	8.4	8.9
1993	6.8	9.5	12.1	8.2	7.8	8.1	8.5
1994	6.3	9.3	12.2	7.9	7.7	7.9	8.4
1995	6.2	9.1	11.6	7.5	7.5	7.5	8.1
1996	5.4	8.7	10.6	6.9	6.6	6.8	7.4
% Change							
1995-96	-13%	-4%	-9%	-8%	-12%	-9%	-9%
1987-96	-36%	4%	-11%	-12%	-11%	-12%	-11%
1987-91 Average	8.3	9.1	12.8	7.9	7.5	7.8	8.5
1992-96 Average	6.4	9.1	11.8	7.8	7.4	7.7	8.3
% Change	-23%	1%	-8%	-1%	0%	-1%	-3%

This section reports trends in amounts of chemicals released to the environment by the petroleum refining industry from 1988 to 1996. It is based on the U.S. Environmental Protection Agency's annual Toxics Release Inventory or TRI, which was created by the 1986 Emergency Planning and Community Right-to-Know Act. Initially, companies reported only on chemicals they released to the environment. As required by the 1990 Pollution Prevention Act, they now also report on waste management and pollution prevention activities that involve a much larger amount of chemicals. Releases of TRI chemicals to the environment typically fall under existing air, water and land permits and do not necessarily constitute exposure of the chemicals to the public.

This report focuses on trends in releases to the environment—the original purpose of the TRI. The task is complicated by periodic changes in reporting requirements and in the list of chemicals included in the program. For example, starting with the 1995 reporting year, the TRI has been expanded and now includes more than 600 chemicals. Information on the newly listed chemicals for 1995 and 1996 is included here, but to make comparisons with previous years more meaningful, this report—except as noted—excludes all chemicals delisted since 1988 and distinguishes between chemicals that have been part of the TRI since 1988 and those subsequently added. Moreover, due to differences in methods of estimating releases by refineries—and changes in the mix of chemicals and companies—TRI data must be interpreted with care.

EPA does not publish information about TRI releases until about 18 months after the end of the year in which they occur. Therefore, to make this report current, API collected information from individual refineries and estimated 1996 releases for the entire petroleum refining industry. (Comparable data on all U.S. industries cannot be included because EPA has not yet published it.)

API publishes voluntary standards that help ensure safe refinery practices and equipment. For example, API has standards that cover the design, construction, repair and certification of equipment such as aboveground storage tanks. Also, API's Inspector Certification Programs ensure the competence of personnel responsible for inspecting pressure vessels, tanks, and piping.

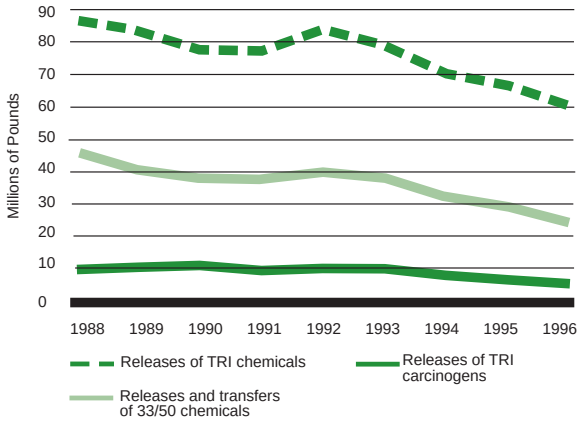
Results

Since 1988, the petroleum refining industry has made significant progress in decreasing its chemical releases to the environment. Comparing only chemicals that have been part of the TRI each year from 1988-1996 (not those subsequently added or delisted), the amount released from refineries declined by 10 percent from 1995 to 1996—and by 32 percent since 1988 (see Figure 1). When adjusted for refinery input, releases of these chemicals declined by 11 percent from 1995 to 1996—and by 36 percent since 1988 (see Table 3). For all TRI chemicals, releases from petroleum refineries amounted to 76 million pounds in 1996, a decrease of 2 percent from the previous year.

Releases of TRI chemicals classified as carcinogens declined by 24 percent from 1995 to 1996 (to less than 4.3 million pounds) and by 53 percent since 1988 (see Figure 1).

Figure 1. Refinery Releases and Transfers[1]

Since 1988, total releases of TRI chemicals have declined by 32 percent, releases and transfers of chemicals in EPA's 33/50 program by 49 percent and releases of carcinogens by 53 percent.



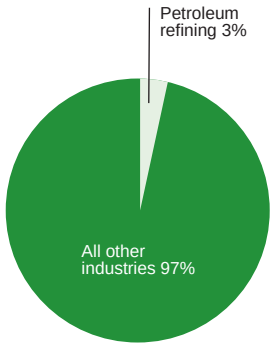
[1]Refinery releases of TRI chemicals do not include delisted chemicals and chemicals added since 1990. EPA's 33/50 program ended in 1995.

EPA's 33/50 program, which began in 1988 and ended in 1995, was a voluntary effort to reduce releases of 17 targeted chemicals—including several carcinogens—by 33 percent in 1992 and by 50 percent in 1995. By 1996, refineries had achieved a 49-percent reduction (see Figure 1). The reductions were primarily due to the decline of releases and transfers of benzene, toluene, xylenes, and methyl ethyl ketone.

Among major U.S. industries, petroleum refining ranked eighth in releases to the environment in 1995, after chemicals, primary metals, paper, plastics, transportation equipment, fabricated metals and food. Petroleum refining's share of total releases was only 3 percent in 1995 (see Figure 2).

Figure 2. Petroleum Refining's Share of TRI Releases: 1995[1]

Of the 2.5 billion pounds of TRI chemicals released by all industries in 1995, petroleum refining's share was 3 percent.



[1]*EPA has not yet released 1996 data.*

Refineries reported managing 2.6 billion pounds of TRI chemicals in refinery wastes during 1996. Seventy-one percent of these were treated to reduce volume or toxicity prior to disposal; 16 percent were burned for energy recovery; and 10 percent were recycled (see Figure 3). Most of the remaining 3 percent entered the environment as air emissions (see Figure 4).

Refineries reported managing nearly 53 million pounds of TRI chemicals in refinery waste classified as carcinogens during 1996—a 26-percent reduction from the amount in 1995.

Figure 3. Management of TRI Chemicals in Waste: 1996

Refineries treated or burned as fuel most of the 2.6 billion pounds of TRI chemicals in refinery wastes.

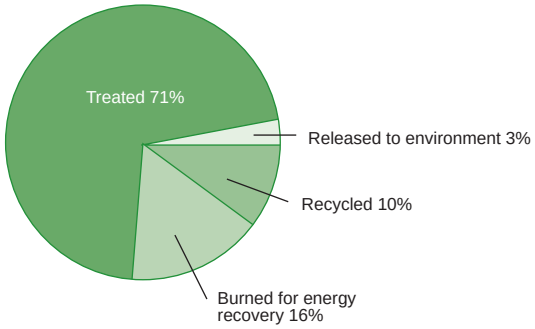
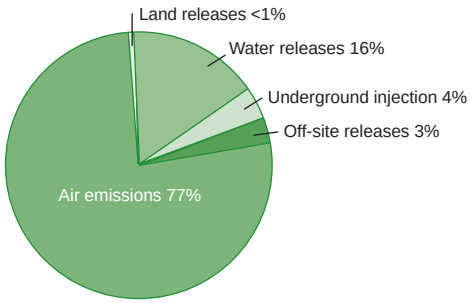


Figure 4. TRI Chemicals Released by Refineries: 1996

Most of the 76 million pounds of TRI chemicals refineries released to the environment were emitted into the air.



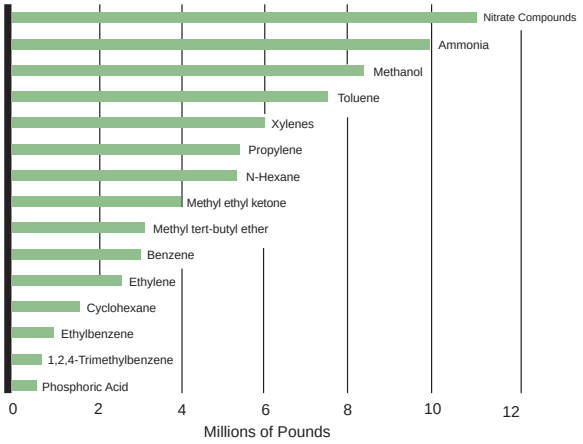
Nature of Releases

Fifteen chemicals constitute the majority of refinery releases, with more nitrate compounds released than any other chemical (see Figure 5). Nitrogen compounds occur naturally in crude oil but are considered impurities. Hydrotreating removes some of this nitrogen as ammonia, which is then converted to nitrate compounds in the wastewater treatment plant.

Ammonia and methanol represent a substantial portion of the remainder of refinery releases. Ammonia is formed when nitrogen is removed from crude oil. Methanol, also known as wood alcohol, is used to produce MTBE (methyl tertiary butyl ether), which is a fuel additive that

Figure 5. Releases of Refineries' Top 15 TRI Chemicals[1]: 1996

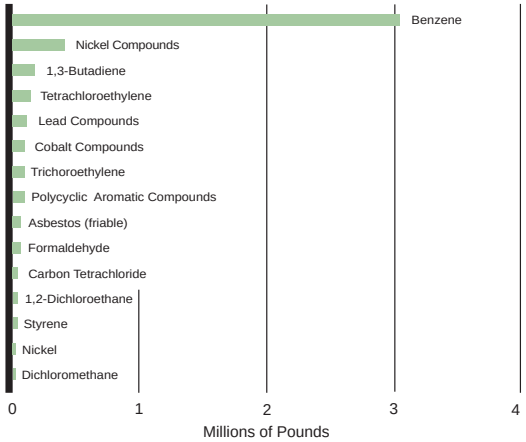
Most refinery releases of TRI chemicals were nitrate compounds and ammonia.



[1]Release amounts are from Table 6.

Figure 6. Refinery Releases of Top 15 TRI Carcinogens[1]: 1996

Benzene was 4 percent of refineries' total releases and 71 percent of their releases of TRI carcinogens. In 1996, releases of benzene decreased by 21 percent from the previous year.



[1]Release amounts are from Table 11.

increases octane and raises oxygen content. The sharp increase in methanol releases in 1996 is due to refineries now reporting methanol emissions from vents in their hydrogen generation plants.

Other chemicals commonly released from refineries include ethylene and propylene, which form when crude oil is refined. Also, benzene, toluene, and xylenes—which are present in crude oil—are separated and released during the refining process.

Although 164 chemicals in the TRI are categorized as carcinogens, only 21 of these were released by refineries in 1996. The most common is benzene. In 1996, benzene constituted 4 percent of refineries' releases of all TRI chemicals and 71 percent of their releases of TRI carcinogens (see Figure 6).

Definitions

Air releases: Chemicals emitted into open air. May come from either "point" or "non-point" sources. Point sources include stacks, vents, ducts, and pipes. Non-point sources (also known as fugitive emissions) include valves, seals, flanges, compressors, building ventilation systems, and evaporation from surface impoundments and spills.

Carcinogen: Following EPA's classification scheme, a chemical is considered a carcinogen if (a) the International Agency for Research on Cancer has found it to be a known human carcinogen or suspected carcinogen; (b) the National Toxicology Program has listed it as a known human carcinogen or suspected carcinogen; or (c) the Occupational Safety and Health Administration regulates it as a carcinogen.

Energy recovery: Wastes burned as fuel in furnaces, kilns or boilers. Does not include incineration.

Land releases: Chemicals stored or treated on land. They may be sent to landfills, broken down by incorporation in the soil (land farming) or deposited in surface impoundments—ponds, lagoons or pits. EPA also categorizes leaks and spills from facilities as land releases—for example, from underground pipelines or storage tanks.

Recycling: Recovering materials from wastes for the same or another use. Includes regeneration—restoring the operative properties of solvents, resins, and other materials so they can be reused.

Releases: Chemicals that enter the environment either on- or off-site (in EPA terminology, on-site releases and off-site disposal). Chemicals may be emitted into the air, discharged into bodies of water, deposited on land or injected underground.

Transfers: Chemicals sent to municipal sewage plants (in EPA terminology, Publicly Owned Treatment Works or POTWs) or other off-site facilities for treatment.

Treatment: Reducing the amount or toxicity of wastes by physical, chemical or biological means. Refineries separate solids and liquids, then treat the liquids to separate oil and water. The separated oil may be subjected to emulsion-breaking polymers, incinerated or, in the case of organic wastes, broken down by the metabolic processes of micro-organisms.

Underground injection: Depositing chemicals underground in strictly regulated wells located on-site or off-site.

Water releases: Chemicals that enter streams, rivers, lakes, oceans, and other bodies of water from pipes, waste treatment systems, and storm drains.

Technical Notes

API amended EPA's data to ensure that this report includes all releases from petroleum refineries—and only petroleum refineries. API checked EPA's list of refineries against its own records, U.S. Department of Energy records, and lists of refineries in the *Oil & Gas Journal*.

EPA uses the government's Standard Industrial Classification (SIC) codes to classify facilities into industry groups. But some facilities use more than one code—for example, refineries that produce petrochemicals may use both SIC code 29 (Petroleum Products and Related Industries) and SIC code 28 (Chemical and Allied Products). Facilities with refining and petrochemical operations may use code 28, 29 or another code for multiple industries. Consequently, EPA's records sometimes attribute releases from petroleum refineries to petrochemical plants—or vice versa. As a result of correcting for this, in 1995 API attributed more releases to refineries than EPA did: roughly 78 million pounds versus 63 million pounds.

Where EPA records showed large year-to-year fluctuations in releases, API contacted the refinery for verification. API also deleted ethylene oxide and epichlorohydrin from the list of chemicals released by refineries as they have nothing to do with refining oil.

API revised ammonia releases for the years 1988-1994 to match EPA's current reporting guidelines. This was done by adding aggregated air releases to 10 percent of aggregated non-air releases (water, land, underground injection, and off-site disposal).

API also revised sulfuric acid and hydrochloric acid releases according to EPA's current guidelines. This was done by retaining only air releases.

Amounts of TRI chemicals may differ between editions of this report for two main reasons: (a) API estimates TRI data for the most recent year and replaces this estimated data with actual EPA data in the next edition of the report and (b) EPA provides API with updated data for some previous years, which may contain revisions submitted by refineries.

API follows EPA's most recent classification scheme for identifying carcinogens for all years. For example, carcinogen amounts for the years 1988 to 1996 were based on EPA's 1995 list of carcinogens, the most recent list available. As a result of chemicals added to the 1995 list, carcinogen amounts for 1988 to 1995 have been revised from the previous edition.

API Estimates

Refineries representing over 85 percent of U.S. capacity responded to API's request for information about 1996 releases. To estimate total releases for the whole petroleum refining industry for 1996, API used the percent change from 1995 releases for the refineries that responded in 1996—and applied it to the 1995 total.

API estimates may differ from the results that would have been obtained if the entire industry, or a different group of refineries, had provided information about 1996 releases. In addition, the estimates do not take into account the possibility of revisions of TRI numbers by refineries. Table 14 gives the margin of error representing the 95-percent confidence interval for API's estimates—the range in which the actual value almost certainly lies. The probability is 95 percent that the true amount for the industry is within the range.

For example, API estimated that refinery releases totaled 76 million pounds in 1996. The margin of error for this estimate is 2.2 percent. This means that API is 95-percent confident that the true value of releases of TRI chemicals is between 75 million and 78 million pounds.

Table Notes

Tables 5 and 9 have been added to this year's report. These tables give trend information about the releases of comparable TRI chemicals and carcinogens by medium from 1988 to 1996.

In some cases, totals may not equal the sum of their components due to independent rounding.

In tables showing amounts, a value of 0 represents less than 500 pounds. A value of 0 percent represents less than 0.5 percent.

Participating Companies

Amerada Hess Corporation
Amoco Corporation
ARCO Products Company
Ashland Petroleum Company
Basis Petroleum, Inc.
BP Oil Company
Cenex, Inc.
Chevron U.S.A. Products Company
CITGO Petroleum Corporation
Clark Refining & Marketing, Inc.
Coastal Corporation, The
Colorado Refining Company
Conoco Inc.
Crown Central Petroleum Corporation
Diamond Shamrock Refining Company, LP
Ergon, Inc.
Exxon Company, U.S.A.
Farmland Industries, Inc.
Fina Oil and Chemical Company
Flying J Inc.
Frontier Refining Inc.
Giant Industries, Inc.
Hunt Refining Company
Huntway Refining Company
Kern Oil & Refining Company
Koch Refining Company L.P.
Lyondell-CITGO Refining Company Ltd.
MAPCO Petroleum, Inc.
Marathon Oil Company
Mobil Oil Corporation
Murphy Oil USA, Inc.
Navajo Refining Company
Pennzoil Products Company
Phillips 66 Company
Placid Refining Company
Powerine Oil Company
Pride Refining Inc.
San Joaquin Refining Company, Inc.
Shell Oil Company
Somerset Refinery
Star Enterprise
Sun Company, Inc.
Tesoro Alaska Petroleum Company
Texaco Refining and Marketing, Inc.
Tosco Refining Company
Total Petroleum, Inc.
U.S. Oil & Refining Company
Ultramar Inc.
United Refining Company
Valero Refining Company
Witco Corporation
Wynnewood Refining Company
Wyoming Refining Company

1 Major Industries' Releases of TRI Chemicals by Medium: 1995[1]

(in thousands of pounds)

Industry	Amount	On-site Releases to Air	On-site Releases to Water	On-site Releases to Land	On-site Underground Injection	Off-site Releases	Share of Total
Chemicals	817,482	50%	11%	8%	28%	4%	33%
Primary metals	500,594	27%	2%	37%	0%	34%	20%
Paper	236,243	90%	7%	1%	0%	1%	9%
Plastics	123,975	90%	0%	0%	0%	9%	5%
Transportation equipment	120,593	91%	0%	0%	0%	9%	5%
Fabricated metals	95,664	85%	0%	1%	0%	14%	4%
Food	86,712	85%	7%	6%	0%	1%	3%
Petroleum refining	78,210	81%	8%	2%	5%	4%	3%
Stone/Clay/Glass	42,074	82%	0%	3%	0%	14%	2%
Furniture	41,068	100%	0%	0%	0%	0%	2%
All other industries	360,438	83%	3%	4%	1%	9%	14%
Total	2,503,053	63%	6%	11%	9%	11%	100%
Petroleum refining's share	---	4%	5%	1%	2%	1%	3%

[1] *EPA has not yet released 1996 data.*

2 Management of All TRI Chemicals in Waste[1] by All Industries and by Refineries: 1991-1996

(in thousands of pounds)

	All Industries					Petroleum Refineries				
Year	Total	Recycling	Energy Recovery	Treatment	Releases to Environment	Total	Recycling	Energy Recovery	Treatment	Releases to Environment
1991	32,880,495	46%	11%	32%	11%	3,756,831	58%	20%	19%	3%
1992	32,982,986	47%	11%	32%	10%	3,342,663	40%	26%	30%	3%
1993	26,146,962	41%	13%	36%	11%	3,027,764	59%	22%	16%	3%
1994	26,546,554	41%	15%	35%	9%	2,259,039	28%	50%	19%	3%
1995	35,074,133	61%	10%	22%	7%	1,441,393	18%	43%	34%	5%
1996	---	---	---	---	---	2,622,325[2]	10%	16%	71%	3%

[1] *This table can be used to compare all industries to petroleum refineries. This table should not be used for year-to-year comparisons because of changes to the list of chemicals considered to be part of the TRI. These numbers correpond to the amounts reported in Section 8 of EPA's Form R.*

[2] *More than 80 percent of the increase from 1995 to 1996 came from a change in one refinery's response between the two years.*

3 Releases of Comparable TRI Chemicals[1] and Refinery Input: 1988-1996

Year	Released by All Industries (thousand pounds)	Change since 1988	Released by Refineries (thousand pounds)	Change since 1988	Total Refinery Input[2] (million barrels)	Refinery Releases per Input (pounds per thousand barrels)
1988	3,750,371	---	86,882	---	5,258	16.5
1989	3,144,553	-16%	82,600	-5%	5,297	15.6
1990	3,156,141	-16%	77,063	-11%	5,325	14.5
1991	2,929,031	-22%	75,934	-13%	5,308	14.3
1992	2,845,795	-24%	82,466	-5%	5,353	15.4
1993	2,411,130	-36%	77,385	-11%	5,483	14.1
1994	2,220,479	-41%	68,739	-21%	5,483	12.5
1995	2,168,185	-42%	65,662	-24%	5,555	11.8
1996	---	---	59,356	-32%	5,668	10.5

[1] *Does not include delisted chemicals and chemicals added since 1990. Ammonia, sulfuric acid, and hydrochloric acid are adjusted for previous years according to EPA's current reporting criteria.*

[2] *Source: "Petroleum Supply Annual," Energy Information Administration.*

4 Releases of Refineries' Most Common[1] TRI Chemicals: 1988-1996

(in thousands of pounds)

Chemical	1988	1989	1990	1991	1992	1993	1994	1995	1996
Ammonia[2]	12,406	12,426	11,264	10,401	9,350	9,958	9,027	10,019	9,901
Methanol	2,554	2,027	1,405	720	833	928	1,054	1,176	8,324
Toluene	15,524	13,148	12,805	13,290	13,207	12,581	10,398	9,608	7,525
Xylenes	10,487	8,831	8,870	8,176	9,487	9,316	7,818	6,909	5,938
Propylene	5,992	7,852	6,807	8,197	6,351	7,248	8,286	7,966	5,427
Methyl ethyl ketone	7,250	5,022	4,582	6,037	7,660	6,541	4,803	4,542	4,015
Methyl tert-butyl ether	1,931	1,748	2,006	1,803	2,127	3,157	2,617	3,004	3,143
Benzene	6,012	5,790	6,933	6,235	5,704	5,734	4,781	3,856	3,043
Ethylene	3,291	4,483	2,918	3,259	2,556	2,784	2,695	3,151	2,622
Cyclohexane	2,077	1,839	1,920	2,600	2,334	2,486	2,261	2,115	1,609
Ethylbenzene	2,081	1,809	1,800	1,868	2,110	1,849	1,790	1,331	1,016
1,2,4-Trimethylbenzene	1,906	1,844	1,693	1,255	1,641	1,326	1,125	923	747
Phenol	3,002	1,761	1,827	1,683	4,554	986	1,698	2,525	476
Other Chemicals	12,372	14,019	12,233	10,411	14,552	12,491	10,385	8,537	5,571
Subtotal[3]	86,882	82,600	77,063	75,934	82,466	77,385	68,739	65,662	59,356
Nitrate Compounds[4]	-	-	-	-	-	-	-	4,977	11,000
N-Hexane[4]	-	-	-	-	-	-	-	6,526	5,349
Other Added Chemicals[5]	-	-	698	765	663	911	554	1,046	706
Total	86,882	82,600	77,761	76,700	83,129	78,296	69,293	78,210	76,410

[1] *All chemicals that were among the top-10 in refineries in at least one year.*

[2] *Adjusted for reporting years 1988-1994 according to EPA's current reporting guidelines.*

[3] *Does not include delisted chemicals and chemicals added since 1990.*

[4] *Added to TRI for reporting year 1995.*

[5] *Includes chemicals added to the TRI since 1990.*

5 Releases of Comparable[1] TRI Chemicals by Medium: 1988-1996

(in thousands of pounds)

Year	Total	On-site Releases to Air	On-site Releases to Water	On-site Releases to Land	On-site Underground Injection	Off-site Releases
1988	86,882	68,785	1,257	5,812	4,536	6,492
1989	82,600	66,067	2,347	2,568	5,641	5,978
1990	77,063	61,863	1,899	2,460	5,697	5,144
1991	75,934	66,122	950	1,441	4,253	3,169
1992	82,466	66,364	1,050	5,375	6,046	3,631
1993	77,385	67,597	890	2,941	1,995	3,962
1994	68,739	60,811	660	1,967	1,259	4,042
1995	65,662	56,002	1,298	1,264	4,015	3,082
1996	59,356	53,072	1,305	280	2,750	1,950

[1]*Does not include delisted chemicals and chemicals added since 1990. Ammonia, sulfuric acid, and hydrochloric acid are adjusted for previous years according to EPA's current reporting criteria.*

6 Releases of Refineries' Top 15 TRI Chemicals by Medium: 1996

(in thousands of pounds)

Chemical	Amount	On-site Releases to Air	On-site Releases to Water	On-site Releases to Land	On-site Underground Injection	Off-site Releases	Share of Total
Nitrate Compounds	11,000	0%	100%	0%	0%	0%	14%
Ammonia	9,901	74%	9%	0%	16%	0%	13%
Methanol	8,324	97%	1%	0%	2%	0%	11%
Toluene	7,525	96%	0%	0%	3%	1%	10%
Xylenes	5,938	97%	0%	1%	1%	1%	8%
Propylene	5,427	100%	0%	0%	0%	0%	7%
N-Hexane	5,349	99%	0%	0%	0%	0%	7%
Methyl ethyl ketone	4,015	99%	0%	0%	1%	0%	5%
Methyl tert-butyl ether	3,143	90%	4%	0%	6%	0%	4%
Benzene	3,043	91%	0%	0%	7%	1%	4%
Ethylene	2,622	100%	0%	0%	0%	0%	3%
Cyclohexane	1,609	99%	0%	0%	0%	0%	2%
Ethylbenzene	1,016	98%	0%	1%	0%	1%	1%
1,2,4-Trimethylbenzene	747	96%	0%	1%	0%	2%	1%
Phosphoric Acid	614	0%	0%	0%	0%	100%	1%
Other Chemicals	6,139	70%	3%	3%	5%	19%	8%
Total	76,410	77%	16%	0%	4%	3%	100%

7 Management of All TRI Carcinogens in Waste[1] by All Industries and by Refineries: 1991-1996

(in thousands of pounds)

	All Industries					Petroleum Refineries				
Year	Total	Recycling	Energy Recovery	Treatment	Releases to Environment	Total	Recycling	Energy Recovery	Treatment	Releases to Environment
1991	3,289,065	64%	11%	16%	10%	44,011	37%	2%	41%	19%
1992	3,106,057	65%	11%	15%	9%	64,779	36%	22%	28%	14%
1993	2,525,933	60%	11%	18%	11%	68,713	31%	30%	26%	13%
1994	2,153,797	53%	12%	22%	12%	76,015	28%	34%	29%	9%
1995	2,746,783	54%	12%	25%	9%	71,360	42%	0%	50%	8%
1996	---	---	---	---	---	52,990	65%	0%	26%	8%

[1] *This table can be used to compare all industries to petroleum refineries. This table should not be used for year-to-year comparisons because of changes to the list of chemicals considered to be carcinogens. These numbers correspond to the amounts reported in Section 8 of EPA's Form R.*

8 Releases of TRI Carcinogens by All Industries and by Refineries: 1988-1996

(in thousands of pounds)

Year	Released by All Industries	Change since 1988	Released by Refineries	Change since 1988
1988	481,969	---	9,122	---
1989	417,271	-13%	9,560	5%
1990	356,945	-26%	10,160	11%
1991	322,350	-33%	8,470	-7%
1992	277,668	-42%	9,079	0%
1993	277,506	-42%	9,004	-1%
1994	264,655	-45%	7,043	-23%
1995	234,327	-51%	5,632	-38%
1996	---	---	4,257	-53%

9 Releases of TRI Carcinogens by Medium: 1988-1996

(in thousands of pounds)

Year	Total	On-site Releases to Air	On-site Releases to Water	On-site Releases to Land	On-site Underground Injection	Off-site Releases
1988	9,122	6,275	85	549	38	2,174
1989	9,560	6,803	99	314	98	2,247
1990	10,160	7,090	34	915	162	1,959
1991	8,470	6,587	42	343	109	1,390
1992	9,079	6,574	25	224	80	2,177
1993	9,004	6,372	39	178	73	2,342
1994	7,043	5,178	32	156	69	1,609
1995	5,632	4,152	29	155	172	1,124
1996	4,257	3,343	19	89	212	594

10 Releases of Refineries' Most Common[1] TRI Carcinogens: 1988-1996

(in thousands of pounds)

Chemical	1988	1989	1990	1991	1992	1993	1994	1995	1996
Benzene	6,012	5,790	6,933	6,235	5,704	5,734	4,781	3,856	3,043
Nickel Compounds	340	139	222	316	197	463	836	623	393
1,3-Butadiene	263	312	352	338	435	441	274	189	158
Tetrachloroethylene	31	13	13	2	4	27	36	46	135
Lead Compounds	424	556	590	173	258	121	135	57	106
Cobalt Compounds[3]	13	18	9	27	28	72	39	79	86
Trichloroethylene[3]	60	78	117	4	2	0	0	2	81
Polycylic Aromatic Compounds[2]	-	-	-	-	-	-	-	77	81
Asbestos (friable)	999	1,114	973	468	1,712	1,729	666	418	50
Formaldehyde	70	85	309	171	324	57	49	34	43
Carbon tetrachloride	28	26	49	46	49	27	22	38	27
1,2-Dichloroethane	16	12	74	17	24	17	22	26	19
Styrene	37	31	16	20	217	175	83	74	15
Nickel	437	602	224	154	98	55	74	76	10
Dichloromethane	45	669	7	15	16	4	4	18	5
1,2-Dibromoethane	15	5	68	2	1	1	4	4	2
Lead	189	38	18	41	2	70	6	4	1
Arsenic	1	19	58	411	0	1	0	1	0
Cadmium Compounds[3]	99	3	48	0	0	0	0	0	0
All Other Carcinogens	44	51	79	29	8	10	13	11	1
Total	9,122	9,560	10,160	8,470	9,079	9,004	7,043	5,632	4,257

[1] *All carcinogens that were among the top-10 in refineries in at least one year.*

[2] *Added to the TRI in 1995.*

[3] *Chemical has been part of TRI since 1988 but listed as carcinogen only since 1995.*

11 Releases of Refineries' Top 15 TRI Carcinogens by Medium: 1996

(in thousands of pounds)

Chemical	Amount	On-site Releases to Air	On-site Releases to Water	On-site Releases to Land	On-site Underground Injection	Off-site Releases	Share of Total
Benzene	3,043	91%	0%	0%	7%	1%	71%
Nickel Compounds	393	15%	1%	13%	0%	70%	9%
1,3-Butadiene	158	98%	2%	0%	0%	0%	4%
Tetrachloroethylene	135	100%	0%	0%	0%	0%	3%
Lead Compounds	106	1%	2%	10%	0%	87%	2%
Cobalt Compounds	86	0%	2%	4%	0%	94%	2%
Trichloroethylene	81	100%	0%	0%	0%	0%	2%
Polycyclic Aromatic Compounds	81	33%	1%	14%	0%	52%	2%
Asbestos (friable)	50	0%	0%	0%	0%	100%	1%
Formaldehyde	43	100%	0%	0%	0%	0%	1%
Carbon Tetrachloride	27	100%	0%	0%	0%	0%	1%
1,2-Dichloroethane	19	100%	0%	0%	0%	0%	0%
Styrene	15	40%	0%	0%	0%	59%	0%
Nickel	10	17%	9%	0%	0%	74%	0%
Dichloromethane	5	99%	1%	0%	0%	0%	0%
Other Carcinogens	5	77%	4%	0%	0%	20%	0%
Total	4,257	79%	0%	2%	5%	14%	100%

12 Releases and Transfers of "33/50" Chemicals[1] by All Industries and by Refineries: 1988-1996

(in thousands of pounds)

Year	Released by All Industries	Change since 1988	Released by Refineries	Change since 1988
1988	1,495,489	---	45,410	---
1989	1,395,062	-7%	39,105	-14%
1990	1,263,960	-15%	37,030	-18%
1991	1,000,533	-33%	36,113	-20%
1992	902,645	-40%	38,346	-16%
1993	799,314	-47%	36,969	-19%
1994	744,432	-50%	30,820	-32%
1995	644,430	-57%	27,539	-39%
1996	---	---	22,965	-49%

[1] *EPA's 33/50 program ended in 1995.*

13 Releases and Transfers of "33/50" Chemicals[1] by Refineries: 1988-1996

(in thousands of pounds)

Chemical	1988	1989	1990	1991	1992	1993	1994	1995	1996
Toluene	16,149	13,904	13,081	13,606	13,466	12,960	10,716	9,973	7,991
Xylenes	11,509	9,965	9,017	8,387	9,779	9,676	8,259	7,373	6,751
Methyl ethyl ketone	7,407	5,057	4,589	6,039	7,661	6,548	4,854	4,588	4,017
Benzene	6,351	6,109	7,136	6,488	5,879	6,024	5,048	4,115	3,062
Nickel and Compounds	843	766	456	476	270	537	986	729	404
Methyl isobutyl ketone	649	487	372	128	235	299	265	236	310
Tetrachloroethylene	31	13	13	2	4	27	36	46	135
Lead and Compounds	682	611	621	220	263	212	146	78	107
Trichloroethylene	60	78	119	4	2	0	3	2	81
Chromium and Compounds	1,163	1,057	1,119	487	540	427	314	114	51
Carbon tetrachloride	29	28	52	46	49	27	22	40	27
1,1,1-Trichloroethane	369	355	398	215	183	228	167	109	24
Dichloromethane	66	669	7	15	16	4	4	18	5
Chloroform	0	0	0	0	0	0	0	0	0
Cyanide Compounds	0	0	0	0	0	0	0	118	0
Cadmium and Compounds	101	5	49	0	0	0	0	0	0
Mercury and Compounds	1	0	0	0	0	0	0	0	0
Total	45,410	39,105	37,030	36,113	38,346	36,969	30,820	27,539	22,965

[1] *Amounts reported for these chemicals differ from the amounts reported in other tables because the 33/50 program included, in addition to releases on- and off-site, transfers to municipal sewage plants and other off-site facilities for treatment. EPA's 33/50 program ended in 1995.*

14 Margins of Error in API Estimates for 1996

(in thousands of pounds)

Category	Estimated Amount	Margin of Error
Chemicals managed in waste by all refineries (Table 2)	2,622,325	±10.5%
All refinery releases (Table 4)	76,410	±2.2%
All refinery releases of carcinogens (Table 8)	4,257	±2.7%
All refinery releases and transfers of "33/50" chemicals (Table 12)	22,965	±3.0%

Refinery residuals are by-products of petroleum refining which are managed by recycling, treatment or disposal. This section discusses trends in the nature, quantity and management of refinery residuals. It is based on an annual API survey of operating refineries in the United States and its territories.

The survey gathers information on various parameters including: refinery age, size, complexity, wastewater treatment systems, residual quantities, and residual management methods. The data obtained from the survey respondents are then extrapolated to estimate residual quantities for the entire U.S. refining industry. The most recent data in this report are for 1996. Seventy-nine refineries representing 57 percent of U.S. refining capacity responded to the survey in 1996.

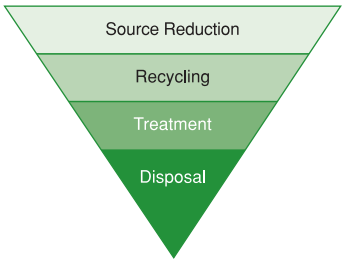
The survey has been conducted since 1987 and originally included 30 residuals. To encourage participation, the survey was streamlined in 1994. The number of residual streams was reduced from 30 to 13, by excluding residual streams that are generated in small quantities and/or that have low management costs. In 1995, two residual streams were combined, further reducing the number of surveyed residuals to 12. This report focuses on trends in the 12 streams in the 1996 survey, all of which have been included from the start. These 12 streams are believed to represent nearly 80 percent of the total quantity of residuals managed at U.S. refineries.

Waste Management Methods

The 1990 Pollution Prevention Act includes a four-tiered waste management hierarchy: source reduction, recycling, treatment, and disposal (see Figure 1). Source reduction is theoretically most desirable because it avoids the creation of waste. Recycling is next best because it reduces waste and conserves resources. Treatment makes unavoidable wastes less bulky or less toxic. Disposal or discarding of wastes is the last resort.

Figure 1. Waste Management Hierarchy

From an environmental perspective, source reduction and recycling are preferable to treatment and disposal.



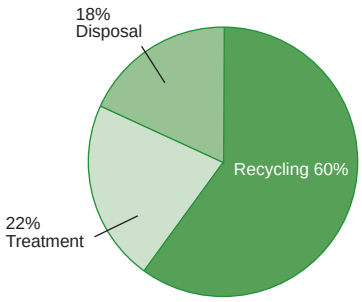
Source reduction to eliminate or reduce residuals, however, has limited application in petroleum refineries. Refinery residuals are generated primarily by processes that remove impurities from crude oil or the fuels produced from crude oil. Generally, economically viable substitutes for crude oil are not available, limiting source reduction opportunities. Therefore, refineries rely on recycling and other methods of pollution prevention.

Results

U.S. refineries have made significant progress in increasing the portion of residuals recycled and in reducing the portions that are treated and disposed. In 1987, when API began conducting its survey, refineries recycled 28 percent of their residuals, treated 44 percent and disposed of the remaining 28 percent. In 1996, refineries recycled 60 percent of their residuals, treated 22 percent, and disposed of the remaining 18 percent (see Figure 2).

Figure 2. Management of Refinery Residuals: 1996

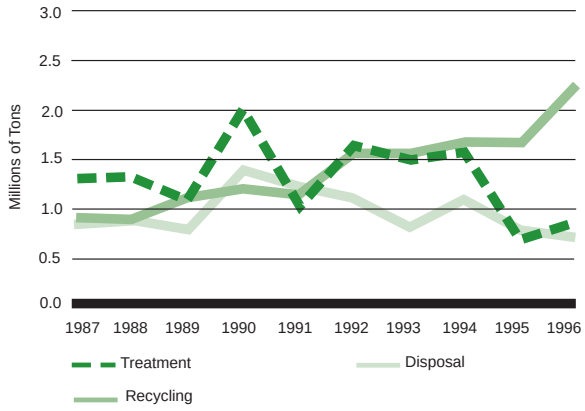
Recycling has become the dominant management practice: refineries recycled about 60 percent of the 3.7 million tons of residuals covered by API's 1996 survey.



In 1995 and 1996, the quantity of residuals recycled was greater than the combined quantities treated and disposed. Between 1987 and 1996, the quantity of residuals recycled increased by 173 percent (see Figure 3). For the same period, the combined quantities treated and disposed decreased by 30 percent.

Figure 3. Residuals Management: Methods and Amounts

Since 1992, refineries have recycled more residual materials than they have discarded.



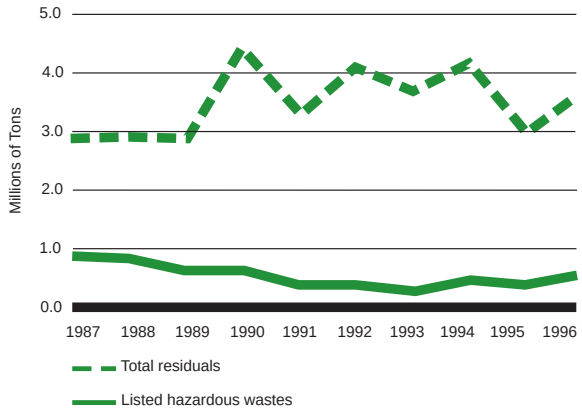
The shift to recycling is also evident in the listed hazardous wastes included in the survey since its inception: API separator sludge, dissolved air flotation float, and slop oil emulsion solids. In 1996, refineries recycled 90 percent of these materials compared to 21 percent in 1987. In 1996, virtually all of these materials were either recycled or treated; less than 0.5 percent were disposed of.

In 1996, U.S. refineries managed an estimated 3.72 million tons of the 12 residuals covered in the survey—lower than the annual estimated quantities for 1992 through 1994 but an increase of 22 percent from 1995 (see Figure 4). When adjusted for refinery input, the increase from 1995 to 1996 is 20 percent (see Table 2).

Increases in the quantities of three streams—spent caustics, DAF float and biomass—account for more than 80 percent of the increase in estimated quantities from 1995 to 1996. These streams often contain very small concentrations of the residual in relatively large volumes of water. Wide variations in the quantities reported for these streams may be due at least in part to differences in how facilities calculate the accompanying volume of water to be excluded.

Figure 4. Total Residuals and Listed Hazardous Wastes[1]

In 1996, total residuals and listed hazardous wastes were slightly above their averages for the 10-year period.



[1]Residual streams included in API's survey from the start.

Three residual streams comprised nearly 68 percent of the residuals included in the 1996 survey:

• Spent caustics—used to absorb petroleum product contaminants such as phenol and hydrogen sulfide,

• Biomass—micro-organisms that were used to purify water used in the refining process, and

• Contaminated soils and solids—materials resulting from cleanup of new spills, remediation of old spills, or excavation for construction.

The four listed hazardous wastes included in the 1996 survey—API separator sludge, DAF float, slop oil emulsion solids, and primary sludges—were 19 percent of total residuals. For the most part, these materials are recycled back into the refining process.

Definitions

Dewatering: Removal of excess/free water from the residual to reduce its volume, improve its handling characteristics, or increase the concentration of recoverable products.

Disposal: Discarding wastes either on- or off-site—for example, sending them to landfills or injecting them underground.

Hazardous wastes: Wastes listed in the Resource Conservation and Recovery Act—for example, API separator sludge. Also, wastes that exhibit one or more of these characteristics: strongly acidic or caustic (corrosive), easy to burn (ignitable), able to release toxic gases (reactive), or containing specific chemicals that can harm the environment (toxic).

Recycling: Recovering materials from residuals for the same or another use. Includes regeneration—restoring the operative properties of solvents, resins, and other materials so they can be reused.

Refinery residuals: By-products of petroleum refining.

Source reduction: Utilizing various techniques to reduce or eliminate waste by preventing it in the first place—at the source.

Treatment: Reducing the volume or inherent toxicity of wastes or residuals by physical, chemical or biological means. Refineries separate solids and liquids, then treat the liquids to separate oil and water. The remains may be subjected to emulsion-breaking polymers, incinerated or, in the case of organic wastes, broken down by the metabolic processes of micro-organisms.

Technical Notes

The residual stream labels in this report are not used in a regulatory sense. Whereas EPA regulations implementing RCRA have given these terms special meaning, the usage here is in a broader, more generic sense. Participants in the API survey report the management of all residual type materials. This includes residuals that are recycled or reclaimed—which may be excluded from the regulatory definitions of solid and hazardous wastes—as well as materials that are discarded.

In the 1995 survey, two primary sludge categories—one resulting from the gravitational separation of oil and water and the other from physical/chemical separation—were combined into a single "primary sludges" category, reducing the number of residual streams in the survey from 13 to 12.

Changes were made in the 1995 survey to make the data between facilities more comparable. Prior to the 1995 survey, some facilities were reporting the quantity of residual prior to dewatering, while others were reporting the quantity managed after dewatering. The 1995 survey, however, specified that only the quantity of residual remaining after dewatering is to be reported, without the recovered water or oil. This provides for a consistent basis of response and more accurately reflects the quantities of residuals managed. This approach was continued with the 1996 survey. To make data for all years comparable, data for 1987 through 1994 were adjusted by deleting quantities considered to be recovered water or oil rather than true residuals. The two specific adjustments made to data for the years 1987 through 1994 were: (i) quantities managed by wastewater treatment were deleted from the streams that are reduced by dewatering. These include *tank bottoms, API separator sludge, DAF float, primary sludges, slop oil emulsion solids, biomass and pond sediments* streams; (ii) quantities listed as recycled to a crude unit were deleted from the *tank bottoms, API separator sludge, primary sludges, biomass and pond sediments* streams. Due to these data adjustments, estimates of residual quantities for the years 1987 through 1994 have been revised from the previous edition.

The 1995 survey also improved reporting consistency by combining all land spreading/land farming into a single land treatment category. To adjust for this change in definition, land spreading was deleted from disposal quantities for previous years and was added to land treatment under the treatment category. This makes the data comparable from 1987 to 1996.

A table in previous editions of the report—which presented margins of error for estimated residual quantities from 1987 onward—has been deleted here. The margins of error for 1987-1994 were calculated for data that included quantities of residuals prior to dewatering. Since 1987-1994 data have now been adjusted by only retaining residual quantities remaining after dewatering, the margins of error are no longer valid for this revised data.

API Estimates

For the 1996 survey, API sent questionnaires to 152 active refineries in the United States. The 44 companies that responded represent 79 refineries, which comprise 57 percent of U.S. refining capacity.

To estimate amounts of refinery residuals for the industry as a whole, an extrapolation was performed using regression analysis with refinery capacity as the explanatory variable.

API's estimates may differ from the results that would have been obtained if the entire industry, or a different group of companies, had participated in the survey. A margin of error representing the 95-percent confidence interval for API's estimates is the range in which the actual value almost certainly lies. The probability is 95-percent that the true amount for the industry is within this range.

In 1996, API estimated that refinery residuals totaled 3.72 million tons. The margin of error for this estimate is plus or minus 7.7 percent. This means that API estimates with 95-percent certainty that refinery residuals were between 3.43 million tons and 4.01 million tons. In 1995, the margin of error was plus or minus 7.4 percent for an estimate of 3.05 million tons.

Table Notes

In some cases, totals may not equal the sum of their components due to independent rounding.

A value of 0 percent in the tables represents less than 0.5 percent.

Participating Companies

American Refining Group, Inc.
ARCO Products Company
Ashland Petroleum Company
Big West Oil Company
BP Oil Company
Cenex, Inc.
Chevron U.S.A. Products Company
CITGO Petroleum Corporation
Clark Refining & Marketing, Inc.
Coastal Corporation, The
Conoco Inc.
Countrymark Cooperative, Inc.
Crown Central Petroleum Corporation
Diamond Shamrock, Inc.
Ergon, Inc.
Exxon Company, U.S.A.
Farmland Industries, Inc.
Fina Oil and Chemical Company
Giant Refining Company
Golden Bear Oil Specialties
Hunt Refining Company
Huntway Refining Company
La Gloria Oil and Gas Company
MAPCO Petroleum, Inc.
Marathon Oil Company
Mobil Oil Corporation
Montana Refining Company
Murphy Oil USA, Inc.
National Cooperative Refinery Association
Neste Trifinery Petroleum Services
Pennzoil Products Company
Phillips 66 Company
Shell Oil Company
Somerset Refinery
Sound Refining, Inc.
Star Enterprise
Tesoro Alaska Petroleum Company
Texaco Refining and Marketing, Inc.
Tosco Refining Company
Total Petroleum, Inc.
U.S. Oil & Refining Company
United Refining Company
Valero Refining Company
Wynnewood Refining Company

1 Types of Estimated Refinery Residuals: 1987-1996

(in thousands of tons)

Residual	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Spent caustics	675	656	716	894	908	1,425	1,434	1,378	988	1,271
Biomass	486	527	405	506	428	550	687	773	582	729
Contaminated soils and solids	186	242	496	915	785	953	631	661	525	522
Dissolved air flotation float[1]	391	424	273	259	201	238	182	355	164	276
Slop oil emulsion solids[1]	113	157	164	187	102	51	44	49	225	218
Tank bottoms	126	92	113	128	91	98	110	87	83	180
Fluid cracking catalyst or equivalent	171	189	185	259	204	197	197	286	173	143
Primary sludges - gravitational and physical/chemical separation[1]	-	-	-	-	110	236	197	328	128	131
API separator sludge[1]	400	281	251	194	90	95	82	101	37	97
Pond sediments	285	289	224	1,038	371	271	143	143	65	69
Other spent catalysts	38	38	33	41	23	28	29	18	15	48
Hydroprocessing catalysts	39	37	36	30	33	51	52	53	63	37
Separator sludges (unspecified)[2]	43	49	38	40	-	-	-	-	-	-
Total	2,953	2,981	2,934	4,491	3,346	4,193	3,788	4,232	3,048	3,721

[1] Listed as a hazardous waste under the Resource Conservation and Recovery Act. For this survey, however, these stream labels are used in a broader context and include materials that are not considered hazardous wastes under RCRA.

[2] Counted as primary sludges (gravitational and chemical/physical) starting in 1991.

2 Estimated Refinery Residuals by Management Method and per Refinery Input: 1987-1996

Year	Amount Managed (thousand tons)	Recycling	Treatment	Disposal	Total Refinery Input[1] (million barrels)	Residual Quantity per Input (tons per thousand barrels)
1987	2,953	28%	44%	28%	5,105	0.58
1988	2,981	29%	43%	28%	5,258	0.57
1989	2,934	37%	37%	26%	5,297	0.55
1990	4,491	26%	44%	30%	5,325	0.84
1991	3,346	33%	31%	36%	5,308	0.63
1992	4,193	36%	38%	26%	5,353	0.78
1993	3,788	40%	39%	21%	5,483	0.69
1994	4,232	39%	36%	25%	5,483	0.77
1995	3,048	53%	22%	24%	5,555	0.55
1996	3,722	60%	22%	18%	5,668	0.66

[1] Source: "Petroleum Supply Annual," Energy Information Administration.

3 Estimated Refinery Listed Hazardous Wastes[1] by Management Method: 1987-1996

(in thousands of tons)

Year	Amount Managed	Recycling	Treatment	Disposal
1987	905	21%	54%	25%
1988	862	28%	54%	18%
1989	689	41%	40%	19%
1990	640	46%	34%	20%
1991	394	69%	29%	2%
1992	385	64%	34%	3%
1993	308	74%	24%	2%
1994	506	87%	10%	3%
1995	426	90%	8%	2%
1996	592	90%	9%	0%

[1]*Consists of API separator sludge, dissolved air flotation float and slop oil emulsion solids. For this survey, however, these stream labels are used in a broader context and include materials that are not considered hazardous wastes under RCRA.*

4 Recycling by Technique: 1987-1996

(in thousands of tons)

Year	Amount Recycled	Reclamation and Regeneration	Reuse in Coker	Reuse in Crude Unit	Other Techniques
1987	813	44%	18%	4%	34%
1988	856	37%	21%	5%	36%
1989	1,089	49%	21%	5%	25%
1990	1,174	51%	16%	4%	28%
1991	1,117	48%	16%	8%	28%
1992	1,528	49%	19%	5%	27%
1993	1,527	47%	14%	4%	35%
1994	1,630	25%	26%	8%	41%
1995	1,630	53%	29%	1%	17%
1996	2,218	50%	33%	1%	16%

5 Treatment by Technique: 1987-1996

(in thousands of tons)

Year	Amount Treated	Land Treatment	Wastewater Treatment	Incineration	Other Techniques[1]
1987	1,301	70%	7%	8%	15%
1988	1,292	72%	7%	10%	11%
1989	1,083	69%	10%	13%	8%
1990	1,973	65%	7%	7%	21%
1991	1,033	55%	23%	21%	2%
1992	1,595	45%	39%	11%	4%
1993	1,473	41%	45%	9%	5%
1994	1,534	38%	52%	6%	4%
1995	677	48%	14%	13%	25%
1996	829	26%	24%	14%	35%

[1] *Includes treatment techniques that use chemicals, heat, stabilization and other methods.*

6 Disposal by Technique: 1987-1996

(in thousands of tons)

Year	Amount Disposed of	Landfills	Impoundments	Underground Injection	Other Techniques
1987	838	70%	21%	4%	5%
1988	832	74%	23%	3%	0%
1989	763	93%	2%	2%	3%
1990	1,344	95%	2%	3%	0%
1991	1,198	94%	3%	3%	0%
1992	1,071	94%	3%	3%	0%
1993	788	93%	3%	4%	0%
1994	1,068	94%	2%	3%	1%
1995	742	95%	3%	1%	1%
1996	676	94%	5%	1%	0%

7 Survey Response Rate: 1987-1996

Year	Operating Refineries	Responding Refineries	Share of Population	Share of Capacity
1987	176	115	65%	80%
1988	176	115	65%	80%
1989	183	117	64%	74%
1990	183	103	56%	70%
1991	183	113	62%	73%
1992	169	91	54%	63%
1993	161	89	55%	63%
1994	159	84	53%	64%
1995	149	74	50%	55%
1996	152	79	52%	57%

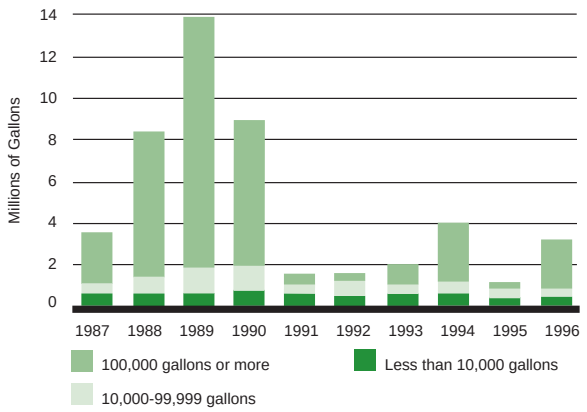
This section discusses oil spills that occur in—or reach—navigable waters under U.S. jurisdiction, including bays, harbors, rivers, lakes, sounds, and oceans up to 200 miles from shore. It is based on U.S. Coast Guard records.

Safe practices for marine transport of oil, covering overfill and vapor control, and strength, integrity and safety of offshore platforms and other structures, are detailed in API specifications and recommended practices.

Results

The number of reported oil spills declined by more than 900 in 1996—or about 10 percent. The volume of spills increased from a record low of 1.2 million gallons in 1995 to a little more than 3.2 million gallons in 1996, primarily because of five large spills (see Figure 1).

Figure 1. Total Amount Spilled

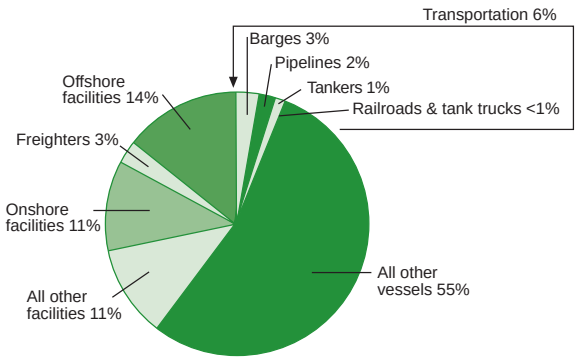


Most spills occurred in inland bodies of water such as rivers, lakes, and bays. And most of what spilled did so during transportation: moving oil from place to place by tanker, barge, pipeline or rail (see Figure 2).

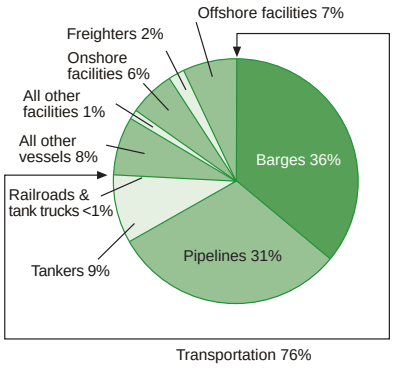
Distillate fuel (diesel fuel and home heating oil) accounted for 70 percent of the total oil spilled. Gasoline and residual oil (a heavy industrial fuel oil) were the next two highest categories.

Figure 2. Sources of Spills: 1996

Number of Spills
Total number of spills = 8,151



Volume of Spills
Total amount spilled = 3,207,839 gallons



Volume of Spills

In 1996, 3.2 million gallons of oil were spilled. This amount is lower than in five of the past ten years, although more than the previous year. To put the total amount spilled into perspective, it is about one-thousandth of one percent (0.001 percent) of the 281 billion gallons of oil consumed by Americans during the year. Three vessel spills and two facility spills were responsible for 2.3 million gallons of the total amount spilled—or about 73 percent.

Large spills—those exceeding 10,000 gallons—accounted for 86 percent of the total volume spilled.

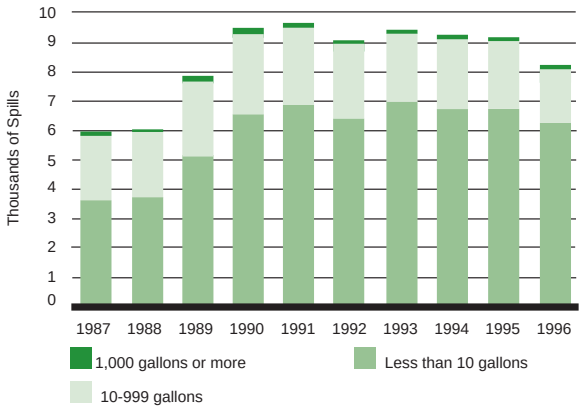
In the second half of the decade covered by this report, an average of 2.4 million gallons of oil was spilled each year compared with 7.3 million gallons in the first half, a decrease of 67 percent. For large spills, the average annual volume decreased 71 percent between the two periods.

Number of Spills

The total number of spills decreased by more than 900 in 1996—or about 10 percent. Most spills were small; about 76 percent were under 10 gallons (see Figure 3).

In 1996, most spills occurred in inland bodies of water such as rivers, lakes, and bays.

Figure 3. Number of Spills



The number of large spills in 1996 was the third lowest annual total recorded over the ten-year period covered by the report. Twenty-one large spills occurred in 1996 compared with 16 the year before, an increase of 31 percent.

Sources of Spills

The Coast Guard divides spills into two broad groups based on where they originate: vessels (boats and ships) and facilities (everything else). In 1996, 61 percent of the spills originated from vessels (see Figure 4) and 39 percent originated from facilities (see Figure 5). Vessels spilled 55 percent of the total volume.

Figure 4. Amount Spilled by Vessels

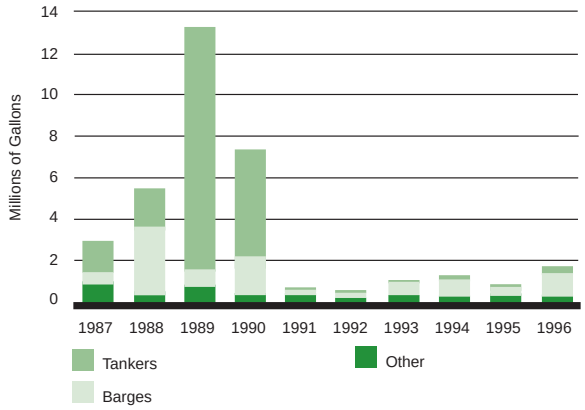
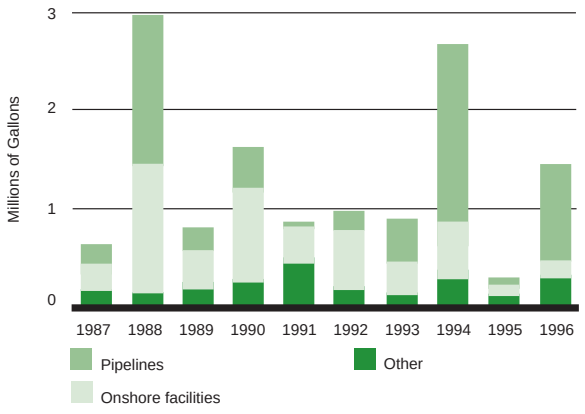


Figure 5. Amount Spilled by Facilities



Most large spills come from barges, pipelines, tankers and onshore facilities. Though such spills occur infrequently, they comprise the bulk of the volume (see Figures 4 and 5). For example, a 10.8 million gallon tanker spill in 1989 was over three-fourths of the annual total. And, a pipeline spill of 957,600 gallons in 1996 was responsible for 30 percent of the annual total.

Definitions

Aircraft: Airplanes, helicopters, and other flying machines.

Barges: Flat-bottomed boats built with tanks for transporting petroleum.

Freighters: Ships that transport non-petroleum products—for example, corn.

LOOP: Louisiana Offshore Oil Port, a man-made port in the Gulf of Mexico.

Natural seep: Place where oil naturally oozes from the ground to form a pool or sheen.

Offshore facilities: Drilling rigs and related production facilities located seaward of the coastline and in inland bodies of water.

Offshore vessels: Ships that carry supplies and other materials to and from offshore facilities.

Onshore facilities: Structures on land that handle petroleum products, including refineries, storage tanks, marketing terminals, and drilling rigs.

Other facilities: Includes the following Coast Guard facility categories—artificial islands, bridges, locks, permanently moored, and not elsewhere classified.

Other vessels: Ships not engaged in transporting petroleum as cargo that, nonetheless, have oil on board—for example, tugboats and fishing boats.

Pipelines: Series of pipes with pumps, valves, and control devices that transport crude oil or petroleum products.

Railroads: Railroad cars with tanks that carry petroleum products as cargo.

Tankers: Large marine vessels with tanks that carry liquid cargo such as crude oil and gasoline.

Tank trucks: Trucks with tanks that carry liquid cargo such as gasoline.

Unknown: Sources of spills that cannot be defined further due to missing or incomplete Coast Guard records.

Vehicles: Motor vehicles not engaged in transporting petroleum as cargo that, nonetheless, have oil on board.

Technical Notes

While these data generally track Coast Guard data, there are some differences. For example, where API's analysis shows there has been double-counting, it has been corrected. Also, API has not counted non-petroleum spills—for example, vegetable oil spills—that the Coast Guard includes.

API attempted to verify all spills of more than 10,000 gallons in local newspapers and trade publications such as the *Oil Spill Intelligence Report* and *Golob's Oil Pollution Bulletin.* To verify pipeline spills, API also checked the records of the U.S. Department of Transportation's Office of Pipeline Safety. If one of these sources cited a spill the Coast Guard had not recorded, API included it—but, only if a second source confirmed it.

Table Notes

API made corrections to 1995 data regarding spills with missing volumes. Therefore, some 1995 figures may differ from those reported in the fifth edition of this publication.

The figures for onshore and offshore facilities have been revised for 1992 through 1995. API made changes to correct an error in which mobile facilities were categorized as offshore rather than onshore.

Spill volume totals may not equal the sum of their components due to independent rounding. In tables showing total volumes of spills, a value of 0 represents less than 500 gallons.

The last row of Tables 1 through 7 represents the percent change between the first half and the second half of the decade covered by this report. Percent changes are based on exact averages and, in some cases, may not agree with the rounded averages shown in the tables.

1 Total Number of Oil Spills by Size: 1987-1996

Year	Under 10 gallons	10-999 gallons	1,000-9,999 gallons	10,000-99,999 gallons	100,000+ gallons	Total
1987	3,544	2,250	128	23	8	5,953
1988	3,626	2,238	125	29	11	6,029
1989	5,024	2,580	136	37	7	7,784
1990	6,480	2,720	164	43	11	9,418
1991	6,791	2,620	138	25	3	9,577
1992	6,322	2,556	105	22	3	9,008
1993	6,897	2,316	120	16	3	9,352
1994	6,659	2,376	144	21	8	9,208
1995	6,648	2,330	75	14	2	9,069
1996	6,182	1,843	105	16	5	8,151
1987-91 Average	5,093	2,482	138	31	8	7,752
1992-96 Average	6,542	2,284	110	18	4	8,958
% Change	28%	-8%	-21%	-43%	-48%	16%

2 Total Volume of Oil Spills by Size: 1987-1996

(in thousands of gallons)

Year	Under 10 gallons	10-999 gallons	1,000-9,999 gallons	10,000-99,999 gallons	100,000+ gallons	Total
1987	6	191	360	575	2,480	3,612
1988	6	195	384	870	7,014	8,469
1989	9	225	403	1,212	12,140	13,988
1990	11	207	460	1,501	6,757	8,936
1991	11	204	420	483	486	1,604
1992	12	205	310	689	367	1,583
1993	12	160	334	563	923	1,993
1994	12	168	401	616	2,831	4,029
1995	13	149	201	456	361	1,181
1996	11	146	300	414	2,337	3,208
1987-91 Average	9	204	405	928	5,775	7,322
1992-96 Average	12	166	309	548	1,364	2,399
% Change	39%	-19%	-24%	-41%	-76%	-67%

3 Total Number and Volume of Oil Spills by Source: 1987-1996

(volume in thousands of gallons)

Year	Number from Vessels	Number from Facilities	Total Number	Volume from Vessels	Volume from Facilities	Total Volume
1987	3,033	2,920	5,953	2,993	619	3,612
1988	3,282	2,747	6,029	5,470	2,999	8,469
1989	3,733	4,051	7,784	13,190	798	13,988
1990	4,236	5,182	9,418	7,313	1,623	8,936
1991	4,219	5,358	9,577	748	856	1,604
1992	5,653	3,355	9,008	616	968	1,583
1993	5,695	3,657	9,352	1,101	891	1,993
1994	5,385	3,823	9,208	1,328	2,700	4,029
1995	5,519	3,550	9,069	900	281	1,181
1996	4,996	3,155	8,151	1,762	1,446	3,208
1987-91 Average	3,701	4,052	7,752	5,943	1,379	7,322
1992-96 Average	5,450	3,508	8,958	1,142	1,257	2,399
% Change	47%	-13%	16%	-81%	-9%	-67%

4 Number of Oil Spills from Vessels by Size: 1987-1996

Year	Under 10 gallons	10-999 gallons	1,000-9,999 gallons	10,000-99,999 gallons	100,000+ gallons	Total
1987	1,723	1,228	62	13	7	3,033
1988	1,896	1,299	57	23	7	3,282
1989	2,197	1,440	66	25	5	3,733
1990	2,576	1,533	92	28	7	4,236
1991	2,689	1,446	70	12	2	4,219
1992	3,910	1,687	49	6	1	5,653
1993	4,098	1,520	67	8	2	5,695
1994	3,759	1,545	68	11	2	5,385
1995	3,932	1,530	44	11	2	5,519
1996	3,722	1,201	60	10	3	4,996
1987-91 Average	2,216	1,389	69	20	6	3,701
1992-96 Average	3,884	1,497	58	9	2	5,450
% Change	75%	8%	-17%	-54%	-64%	47%

5 Volume of Oil Spills from Vessels by Source: 1987-1996

(in thousands of gallons)

Year	Freighters	Barges	Tankers	Offshore	Other	Unknown	Total
1987	540	574	1,497	3	329	50	2,993
1988	90	3,247	1,816	5	238	73	5,470
1989	326	824	11,572	35	390	43	13,190
1990	81	1,840	5,070	12	251	61	7,313
1991	56	270	97	11	261	52	748
1992	17	219	118	5	172	85	616
1993	78	645	63	13	262	40	1,101
1994	70	829	193	18	159	60	1,328
1995	106	424	132	9	190	39	900
1996	68	1,161	292	10	193	38	1,762
1987-91 Average	219	1,351	4,010	13	293	56	5,943
1992-96 Average	68	656	160	11	195	53	1,142
% Change	-69%	-51%	-96%	-18%	-33%	-6%	-81%

6 Number of Oil Spills from Facilities by Size: 1987-1996

Year	Under 10 gallons	10-999 gallons	1,000-9,999 gallons	10,000-99,999 gallons	100,000+ gallons	Total
1987	1,821	1,022	66	10	1	2,920
1988	1,730	939	68	6	4	2,747
1989	2,827	1,140	70	12	2	4,051
1990	3,904	1,187	72	15	4	5,182
1991	4,102	1,174	68	13	1	5,358
1992	2,412	869	56	16	2	3,355
1993	2,799	796	53	8	1	3,657
1994	2,900	831	76	10	6	3,823
1995	2,716	800	31	3	0	3,550
1996	2,460	642	45	6	2	3,155
1987-91 Average	2,877	1,092	69	11	2	4,052
1992-96 Average	2,657	788	52	9	2	3,508
% Change	-8%	-28%	-24%	-23%	-8%	-13%

7 Volume of Oil Spills from Facilities by Source: 1987-1996

(in thousands of gallons)

Year	Natural Seep	Aircraft	LOOP	Offshore	Onshore	Pipelines	Railroads	Tank Trucks	Vehicles	Other	Unknown	Total
1987	1	2	0	23	285	201	4	26	4	51	23	619
1988	3	8	0	23	1,347	1,545	3	21	1	21	27	2,999
1989	1	1	0	46	410	241	0	29	1	30	38	798
1990	0	4	0	39	978	419	13	14	1	18	138	1,623
1991	0	1	0	41	389	48	0	6	1	73	297	856
1992	0	64	0	25	624	200	0	16	1	24	14	968
1993	0	0	0	19	355	446	3	1	0	27	40	891
1994	0	3	0	21	589	1,850	3	23	1	73	138	2,700
1995	0	2	0	12	116	78	44	0	1	19	9	281
1996	0	2	0	225	190	988	1	3	1	24	12	1,446
1987-91 Average	1	3	0	35	682	491	4	19	2	38	104	1,379
1992-96 Average	0	14	0	60	375	712	10	9	1	33	42	1,257
% Change	-100%	354%	-75%	75%	-45%	45%	156%	-56%	-36%	-13%	-60%	-9%

8 Nature of Oil Spills: 1996

(volume in thousands of gallons)

Material	Number from Vessels	Number from Facilities	Total Number	Volume from Vessels	Volume from Facilities	Total Volume
Distillate fuel oil	1,841	562	2,403	1,244	1,012	2,256
Gasoline	337	117	454	82	209	291
Residuals	79	53	132	234	43	276
Crude oil	174	1,276	1,450	64	131	195
Absorption oil	2	1	3	63	0	63
Unknown oils	1,383	507	1,890	21	9	30
Lubricants	402	232	634	17	7	24
Asphalt	12	12	24	9	12	20
Jet fuel	18	47	65	8	10	18
Waste oils	370	135	505	12	3	15
Benzene & related chemicals	4	7	11	0	8	8
Hydraulic fluid or oil	185	119	304	4	1	5
Naphthas	5	5	10	3	0	3
Bilge oil	166	11	177	2	0	2
Other[1]	9	48	57	0	1	1
Kerosine	4	14	18	0	0	1
Mineral oil	5	9	14	0	1	1
Total	4,996	3,155	8,151	1,762	1,446	3,208

[1] *Includes drilling mud, light ends, liquefied natural gas, spray oil, and transformer oil.*

This section charts progress in guarding against leaks and spills from underground storage tanks and associated piping at gasoline service stations. It is based on a survey of API member companies.

API member companies own or operate more than 35,000 gasoline service stations—about 20 percent of the U.S. total. The 14 companies that participated in the survey represent more than half of these stations—over 19,000 facilities with almost 74,000 underground storage tanks holding motor fuels, used oil, and other products such as kerosene.

Nationwide, the U.S. Environmental Protection Agency regulates about 1.2 million underground tanks at over 500,000 sites. Almost all contain petroleum products. These sites include marketers (such as service stations and convenience stores) who sell gasoline to the public and nonmarketers (such as fleet service operators and local governments) who use tanks solely for their own needs. By the end of 1998, all regulated underground storage tanks must meet federal standards established under the Resource Conservation and Recovery Act. These standards require monthly monitoring to detect leaks, corrosion protection for tanks and associated piping, and installation of special equipment to prevent overfilling and spills.

API standards that help safeguard underground storage tanks cover leak detection, cathodic protection, spill protection and procedures for the installation, removal and lining of underground tanks. These standards are referenced in federal technical regulations for underground storage systems.

Results

At the end of July 1997, more than 80 percent of the underground storage tanks included in API's survey already met December 1998 federal standards for preventing corrosion, overfilling, and spills. The majority of this work involved the replacement of tank systems or the upgrading of existing systems. All tanks in the survey were checked regularly for leaks, with over 60 percent meeting 1998 leak detection requirements (see Table 1).

Sixty-one percent of surveyed tanks met 1998 federal standards for detecting leaks—61 percent of the tanks containing motor fuels, 62 percent of those containing used oil, and 46 percent of those containing other products. The remaining tanks are monitored for leaks using the currently accepted practice of periodic tank testing and inventory control. Members who have deferred the installation of monthly monitoring systems report that they are on target to complete the work by the December 1998 deadline, allowing them to incorporate the latest advances in computer technology.

In addition, 83 percent of the survey population met 1998 standards for protecting tanks and associated piping against corrosion: 83 percent of the tanks containing motor fuels, 76 percent of those containing used oil, and 89 percent of those containing other products.

The 1998 standards also require safeguards against overfilling and spills. The requirements do not apply to tanks where separate transfers are limited to 25 gallons or less. So, of all tanks included in the survey, 94 percent must meet 1998 overfill protection and spill prevention requirements.

Eighty-six percent of the tanks in the survey met the standards for overfilling: 88 percent of those containing motor fuels, 61 percent containing used oil, and 82 percent containing other products. Ninety percent of the tanks in the survey met the standards for preventing spills: 93 percent of those containing motor fuels, 68 percent containing used oil, and 87 percent containing other products.

Definitions

Corrosion protection: Using tanks and piping made of materials that resist corrosion—for example, fiberglass-reinforced plastic—or equipping steel tanks and piping with systems that reverse the electrical current that causes corrosion (cathodic protection).

Leak detection: 1998 standards require monthly monitoring. Methods include measuring tank contents, checking for petroleum products between the walls of double-walled tanks (interstitial monitoring), and monitoring to determine the presence of hydrocarbons in nearby soil and groundwater.

Overfill protection: Using alarms, automatic switches, ball float valves or other devices to avoid overfilling.

Spill prevention: Using equipment that catches and contains small spills when petroleum products are transferred between delivery trucks and storage tanks.

Testing and inventory control: Detecting leaks by reconciling inventories each month and checking tank tightness periodically. May be used until December 1998.

Participating Companies

Amoco Corporation
ARCO Products Company
Ashland Petroleum Company
BP Oil Company
Chevron U.S.A. Products Company
Exxon Company, U.S.A.
Fina Oil and Chemical Company
Marathon Oil Company
Mobil Oil Corporation
Murphy Oil USA, Inc.
Phillips 66 Company
Shell Oil Company
SuperAmerica Group
Texaco Refining and Marketing, Inc.

1 *Progress in Meeting December 1998 Federal Standards for Underground Storage Tanks in Gasoline Stations Owned by Participating API Member Companies: as of July 31, 1997*

Product	Total Number of Tanks Reported	Leak Detection		Corrosion Protection		Overfill Protection		Spill Prevention	
		Required	Upgraded	Required	Upgraded	Required[1]	Upgraded	Required[1]	Upgraded
Motor Fuels	65,751	100%	61%	100%	83%	96%	88%	96%	93%
Used Oil	6,099	100%	62%	100%	76%	72%	61%	72%	68%
Other Products	1,962	100%	46%	100%	89%	75%	82%	75%	87%
Total	73,812	100%	61%	100%	83%	94%	86%	94%	90%

[1] *Tanks with only separate transfers of no more than 25 gallons are excluded.*

This section updates the petroleum industry's progress collecting and recycling used motor oil. It is based on a survey completed by 19 API member companies that own or franchise service stations and quick lube businesses which collect used motor oil from do-it-yourselfers—people who change their own motor oil.

This year, API also contacted the 17 states which adopted used oil collection programs based on API's model legislation in order to obtain estimates on the number of public and private collection centers and the amount of used oil they collected from do-it-yourselfers in 1995 and 1996. The funding from the legislation is used to set up incentives that pay for public collection centers, reducing the need for private collection sites.

A decade ago, the U.S. Environmental Protection Agency estimated that do-it-yourselfers generated more than 200 million gallons of used motor oil annually and that two-thirds may be disposed of improperly—dumped in garbage cans, sewers or backyards. But in a more recent API-commissioned public opinion survey, 79 percent of do-it-yourselfers said they recycle their motor oil. The same survey showed that about 38 percent of households change the oil in their vehicles.

API and its member companies work with state and local governments to educate Americans about the importance of bringing used motor oil to collection centers for recycling. An API survey completed in May 1996 (National Used Oil Collection Study) notes that 30 states have used motor oil recycling programs, operating 3,000 state and local government-sponsored recycling sites.

Recycled motor oil can be rerefined or burned for more energy. One gallon of used oil can generate 38 kilowatt hours of electricity—enough to run the average household for 24 hours.

Results

The API member companies and their independent dealers, who have been responding to API's survey every year since 1991, collected some 24 million gallons of used motor oil in 1996—up 48 percent from 1995. In addition, they operated almost 12,200 drop-off collection centers in 1996—up 23 percent from 1995. These increases may be accounted for at least in part by more comprehensive reporting on the part of the companies surveyed. Since 1991, when the Institute conducted its first survey, API members and their dealers have collected nearly 81 million gallons of used motor oil in 47 states and the District of Columbia.

Based on data received from state agencies—which operate programs based on the API model—between 1995 and 1996, the number of combined public and private centers increased by 5 percent and the amount of used motor oil collected increased by 10 percent.

Promoting Used Motor Oil Recycling

API has developed model legislation based on Florida's used oil collection program, which was created and implemented with the help of API's Florida Petroleum Council. The model bill calls for states to create a special fund to help cities and towns establish curbside and drop-off collection centers—and educate people about why it is important to dispose of used motor oil properly.

Seventeen states have adopted programs based on the model bill: California, Delaware, Florida, Kansas, Kentucky, Louisiana, Maine, Maryland, Minnesota, Missouri, New Hampshire, Rhode Island, South Carolina, Tennessee, Texas, Utah, and Virginia. According to API's national used oil collection study, 30 states and the District of Columbia have at least some type of state-sponsored used oil program.

What Happens To Used Motor Oil?

Used motor oil can be reprocessed as fuel oil or rerefined into lubricating oil that can meet the same API/SAE specifications as virgin motor oil.

Reprocessed oil helps run power plants that produce electricity. It can be used in industrial burners, mixed with asphalts, or blended for marine fuel and other uses. However, reprocessed oil is not of sufficient quality to be used again as lubricating oil.

Reprocessing is the most common method of recycling used oil in the United States. Approximately 85 percent of the oil recycled in this country is currently being reprocessed in one form or another.

Definitions

Do-it-yourselfer: Someone who changes his or her own motor oil.

Used motor oil collection center: May be either of two types: drop-off (people bring their used oil to a designated place) or curbside (people leave used oil on street curbs near their homes for pickup). States, municipalities, independent dealers, and oil companies establish and run used oil collection centers.

Participating Companies

Amoco Corporation
BP America Inc.
Castrol North America Automotive, Inc.
Chevron Corporation
Conoco Inc.
Evergreen Holdings, Inc.
Exxon Company, U.S.A.
Marathon Oil Company
Mobil Oil Corporation
Pennzoil Company
Phillips Petroleum Company
Quaker State Corporation
Safety-Kleen Corporation
Shell Oil Company
Sun Company, Inc.
Texaco Inc.
Unocal Corporation
Valvoline Company, The
Witco Corporation

1 Used Motor Oil Collected by Participating API Member Companies: 1991-1996

Year	Number of Drop-off Centers	Thousands of Gallons Collected
1991	1,820	1,300
1992	8,271	9,900
1993	9,852	12,800
1994	10,808	16,400
1995	9,897	16,300
1996[1]	12,129	24,134

[1] *Increases over 1995 may be accounted for in part by more comprehensive reporting on the part of the companies surveyed.*

2 Number of Drop-off Collection Centers and Gallons of Used Motor Oil Collected by States with Used Oil Programs Based on the API Model Bill: 1995-1996[1]

	Number of Drop-off Centers			Thousands of Gallons Collected		
State	1995	1996	% Change	1995	1996	% Change
California	1,800	2,100	17%	5,000	5,500	10%
Delaware[2]	42	42	0%	139	177	27%
Florida	1,350	1,200	-11%	2,200	2,319	5%
Kansas	---	---	---	---	---	---
Kentucky	273	273	0%	570	605	6%
Louisiana	190	212	12%	---	---	---
Maine	71	78	10%	---	---	---
Maryland[2]	200	200	0%	667	687	3%
Minnesota	1,100	850	-23%	---	---	---
Missouri[2]	83	119	43%	---	---	---
New Hampshire	156	188	21%	37	52	41%
Rhode Island[2]	36	36	0%	144	148	3%
South Carolina	470	509	8%	724	748	3%
Tennessee	443	515	16%	---	---	---
Texas	2,290	2,594	13%	4,000	4,500	13%
Utah	145	190	31%	124	235	90%
Virginia[2,3]	161	161	0%	---	---	---
Total	8,810	9,267	5%	13,605	14,971	10%

[1] *Unless noted, includes government-operated (public) and privately operated. However, no data are available for some states.*

[2] *Government-operated only.*

[3] *Rough estimates.*

This section describes advances in preventing the release of gasoline vapors into the air—when gasoline is transferred between storage tanks and delivery trucks and when motor vehicles refuel. It is based on a survey of API member companies.

The 14 companies that participated in the survey reported on over 19,000 facilities—50 percent of the retail outlets, 4 percent of the bulk plants, and 42 percent of the distribution terminals owned by API member companies. In all, API members own some 35,000 gasoline service stations (about 20 percent of the U.S. total); 1,500 bulk plants (about 14 percent of the U.S. total); and 850 terminals (about 50 percent of the U.S. total).

From the refineries where it is produced, gasoline typically travels by pipeline, barge or tanker to distribution terminals, from where it is taken by truck to retail outlets. Some gasoline also travels by truck to intermediate storage facilities known as bulk plants. These plants send gasoline—again, by truck—to retail outlets and commercial, industrial, and agricultural facilities.

Many retail outlets, bulk plants, and terminals have long been equipped with Stage I vapor controls. These controls contain vapors when gasoline is transferred between storage tanks and delivery trucks. In areas that do not meet federal air quality standards, special nozzles and hoses known as Stage II controls are also required. They contain vapors when cars and trucks refuel.

API standards provide industry with recommended practices for vapor controls and control systems for tank trucks, ships, barges and terminals.

Results

Federal and state laws require Stage I controls in 80 percent of the retail outlets and 94 percent of the bulk plants in API's survey. Stage II controls are required in 59 percent of the retail outlets in the survey. Vapor control units are required in 91 percent of the terminals.

At the end of July 1997, all facilities included in API's survey met or exceeded all vapor control requirements. Vapor control installations at retail outlets exceeded Stage I requirements by 17 percent and Stage II requirements by 10 percent. Although the bulk plants included in the survey were not required to have vapor control systems, 22 percent were equipped with the controls.

Definitions

Bulk plants: Receive gasoline by truck, temporarily store it, then deliver it by truck to retail outlets and other facilities.

Retail outlets: Sell gasoline, diesel fuel, and other products to consumers.

Stage I controls: Contain vapors when gasoline is transferred between trucks and storage tanks above or below ground.

Stage II controls: Contain vapors when cars and trucks refuel.

Terminals: Receive gasoline by barge, pipeline or tanker; temporarily store it in large tanks above ground; then deliver it by truck to bulk plants, retail outlets, and commercial customers, such as car dealerships, schools, police stations, and firehouses.

Vapor control units: Capture and process vapors that would otherwise escape when gasoline is transferred between storage tanks and delivery trucks. Used mainly at distribution terminals, but also at some bulk plants.

Participating Companies

Amoco Corporation
ARCO Products Company
Ashland Petroleum Company
BP Oil Company
Chevron U.S.A. Products Company
Exxon Company, U.S.A.
Fina Oil and Chemical Company
Marathon Oil Company
Mobil Oil Corporation
Murphy Oil USA, Inc.
Phillips 66 Company
Shell Oil Company
Texaco Refining and Marketing, Inc.
Williams Pipe Line Company

1 *Progress Installing Vapor Controls in Facilities Owned by Participating API Member Companies: as of July 31, 1997*

Type of Facility	Number Reported	Stage I Required	Stage I Installed	Stage II Required	Stage II Installed	Vapor Units Required	Vapor Units Installed
Retail outlets	18,619	80%	97%	59%	69%	--	--
Bulk plants	64	94%	94%	--	--	0%	22%
Terminals	354	--	--	--	--	91%	92%

-- not applicable

This section details how much the U.S. petroleum industry is spending on environmental protection—as a whole and sector by sector. It is based on an annual survey conducted by API.

API sends questionnaires to a sample of companies representative of the industry as a whole. To ensure accurate and comparable responses, API includes detailed guidelines and definitions. After checking for consistency and verifying any unusual responses, API estimates expenditures for the industry as a whole. The responses of individual companies remain confidential.

Neither API's estimates nor reported expenditures are adjusted for inflation. All calculations are based on actual amounts reported for 1990 through 1996 and relate solely to the prevention, control, abatement or elimination of pollution from U.S. petroleum operations. Chemical and non-petroleum operations such as coal, shale, and mineral mining are not included.

Trends in expenditures are greatly influenced by government regulations. For a discussion on how new regulations could impact future expenditures, see the October 1997 API report *Cumulative Impact of Environmental Regulations on the U.S. Petroleum Refining, Transportation and Marketing Industries.*

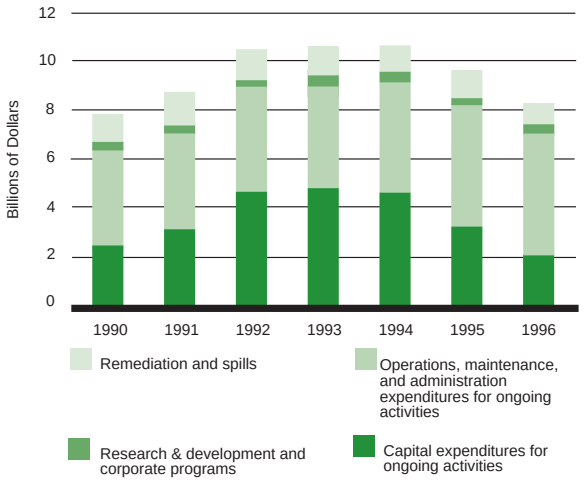
These expenditures do not include financial reserves or other provisions for future activities; fines and penalties; costs associated with U.S. Occupational Safety and Health Administration requirements; insurance premiums and recoveries; or estimates of lost revenue or business opportunities.

Results

The petroleum industry's U.S. environmental expenditures decreased almost $1.4 billion in 1996—to a total of about $8.2 billion (see Figure 1). Expenditures in 1996 were also more than $2.0 billion less than what was spent each year between 1992 and 1994. The larger expenditures between 1992 and 1994 reflect investments oil companies made in new equipment and processes needed to manufacture cleaner-burning fuels—primarily reformulated gasoline and low-sulfur diesel fuel. These major environmental upgrades are now largely completed.

Figure 1. U.S. Environmental Expenditures[1]

In 1996, total environmental spending declined, reflecting completion of much of the capital investment needed to make cleaner fuels.



[1]*Estimated except remediation and spills.*

Much of these expenditures occurred in the refining sector. Thus, much of the reduction in overall environmental expenditures in the past few years is the result of declining capital expenditures in refining. For example, in 1996, refining capital expenditures were about $0.8 billion, down about $1.3 billion from the preceding year. Between 1992 and 1994, the refining sector reported almost $10 billion in total capital expenditures related to the environment. The refining sector still accounted for more than half of the industry's environmental expenditures in 1996, when capital expenditures, operations, maintenance and administration are combined (see Table 2).

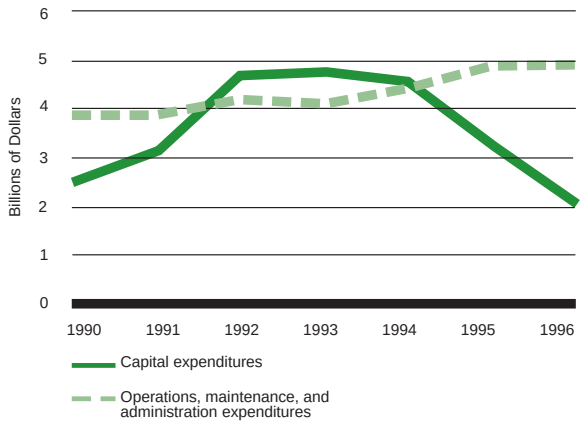
The $8.2 billion in environmental expenditures in 1996 equaled about one-fourth the net income of the top 200 oil and natural gas companies, as reported in the *Oil and Gas Journal.* And they were more than the entire budget of the U.S. Environmental Protection Agency. The expenditures break down to $83 per U.S. household.

Reformulated gasoline, which was introduced in January 1995, as mandated by the 1990 Clean Air Act Amendments, reduces smog-forming emissions of volatile organic compounds and toxic emissions by 15 percent. Low-sulfur diesel fuel, which was introduced in late October 1993, reduces both particulate matter and sulfur emissions. Reformulated gasoline must meet more stringent emission requirements in the year 2000. In preparing to make a fuel that will meet these new requirements, companies will be making additional capital investments through the last few years of the 1990s.

Although environmental capital expenditures declined in 1996 to a total of $2.0 billion, operational, maintenance and administrative expenditures relating to compliance with environmental regulations increased slightly from the previous year to a total of almost $5 billion (see Figure 2).

Figure 2. Trends in Environmental Expenditures for Ongoing Activities

While capital spending declined, operations and maintenance expenditures remained the same.



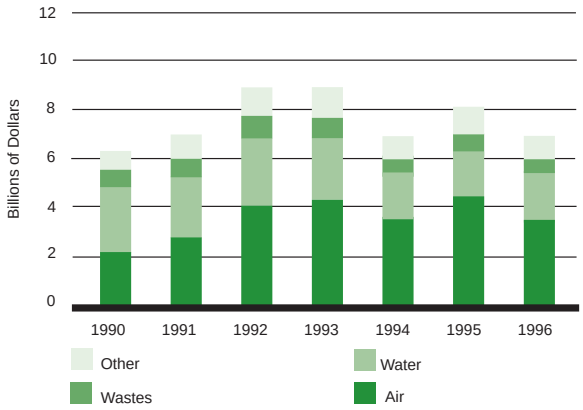
Ongoing Activities

Most of what the petroleum industry spends on the environment is channeled into ongoing activities to prevent or limit pollution. Although down about 14 percent in 1996, these expenditures rose 10 percent since 1990—from an estimated $6.3 billion in 1990 to an estimated $7.0 billion in 1996.

The distribution has changed as well: where water pollution controls were the biggest expense in 1990, about half the industry's environmental expenditures in 1996 related to air pollution controls (see Figure 3). The shift largely reflects changes to comply with the 1990 Clean Air Act Amendments and with state of California requirements—for example, equipping refineries to make cleaner-burning fuels (see Figures 4 and 5).

Figure 3. Spending by Medium[1]

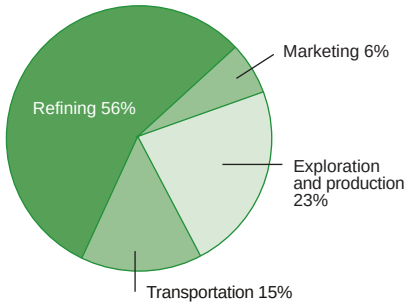
Half of all environmental expenditures are directed at reducing air pollution.



[1]*Ongoing activity only.*

Figure 4. Spending by Business Sector[1]: 1996

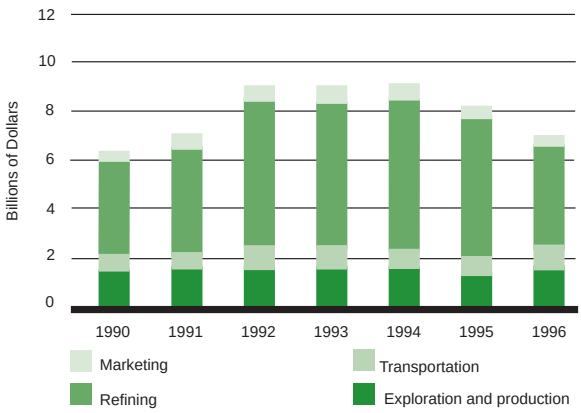
The industry spent about $7 billion on continuing efforts to protect the environment.



[1]*Ongoing activity only.*

Figure 5. Trends of Spending by Business Sector[1]

Environmental expenditures are greatest in the refining sector.



[1]*Ongoing activity only.*

Remediation and Spills

The next biggest categories of environmental expenditures are remediation and spills—cleaning up contaminated soil and water. API does not estimate these expenditures for the industry as a whole because they are less predictable, vary widely among companies, and often relate to discontinued practices. The amounts given are the sum of the expenditures survey participants report to API. Thus, more is actually spent on remediation and spills than is reported here. (Expenditures associated with the 1989 spill from the Exxon Valdez are not included.)

Survey participants spent about $0.9 billion on remediation and spills in 1996, down from almost $1.2 billion in each of the preceding three years (see Table 3). About $1.1 billion was spent in these areas in 1990 and $1.3 billion in both 1991 and 1992. Because the companies participating in the survey change each year, API cannot determine how closely these amounts approximate the industry trend.

Research and Development

While a large share of industry spending for research and development occurs in individual sectors, such as refining or marketing, some oil companies also have centralized research and development programs. For the most part, companies focus on finding new and better ways to reduce air pollution from products and operations. In 1996, the petroleum industry spent an estimated $103 million on such programs, down from $156 million in 1995.

Corporate Programs

These include company environmental departments and voluntary programs to improve environmental quality and to support community and environmental groups. In 1996, the petroleum industry spent an estimated $187 million on such programs, 33 percent more than in 1995. Examples of some of these programs are summarized in the September 1996 API report, *Promoting Partnerships: Cooperation Between the Petroleum Industry and Environmental, Educational and Community Groups.*

Definitions

Air pollution: Substances emitted into open air that are targeted for reduction by the Clean Air Act and other environmental laws—for example, carbon monoxide, hydrocarbons, lead, nitrogen oxides, particulates, and sulfur dioxide.

Corporate programs: Activities of company environmental departments. Also, voluntary efforts to improve environmental quality such as buying and destroying older, high-polluting cars, providing free engine tune-ups, collecting used oil, and supporting environmental education programs.

Environmental expenditures: Costs incurred that relate to the prevention, control, abatement or elimination of environmental pollution. Expenditures are the incremental costs reported by a unit in a facility that would not have been incurred if environmental issues had not been considered.

Low-sulfur diesel fuel: A specially formulated diesel fuel that reduces particulate emissions from diesel-powered engines.

Ongoing activities: Capital, operating, maintenance, and administrative expenses associated with routine operating practices in each sector of the industry.

Other media: Recurring undertakings that are not reported under air, water or wastes—for example, removing abandoned production platforms, supporting oil spill cooperatives, and paying Superfund taxes.

Reformulated gasoline (RFG): A specially blended, cleaner-burning gasoline designed to fight urban smog. It reduces carbon monoxide and toxic emissions as well as smog-forming emissions. It has less benzene and no heavy metals. RFG is available in all octane grades, and its use is currently required in about one-quarter of the nation.

Remediation: Cleaning up soil and groundwater contamination. Such contamination is caused by leaks from storage tanks, pipelines, pits, settlement ponds or underground piping. Contamination may also have resulted from practices allowed in the past, but no longer permitted.

Research and development: Investigating new technologies to limit or reduce pollution from products and operations—for example, reformulating gasoline and diesel fuel.

Spills: Sudden releases of crude oil or petroleum products caused by malfunctions or accidents.

Waste management: Collecting, treating, recycling and disposing of solid or contained wastes. Includes efforts to prevent pollution by reducing waste at the source.

Water pollution: Discharging into bodies of water substances targeted by the Clean Water Act and other environmental laws—for example, oils, metals, solids, and toxic chemicals.

Technical Notes

API's environmental expenditures survey is sent to a stratified sample of the industry: all large and mid-size companies, plus a randomly selected group of smaller companies. Each year since 1990, the survey has been mailed to about 800 companies. In 1996, 107 companies completed it. Those completing the survey represent a large share—from 60 percent to 95 percent—of the variables used to estimate expenditures for the entire industry (see Table 7).

To estimate expenditures for the industry as a whole, API used regression and ratio analysis. Different variables were used for different parts of the industry: upstream revenues for exploration and production, trunkline miles for transportation, refinery capacity for refining, and gasoline sales for marketing. To estimate industry-wide expenditures for research and development and corporate programs, API used a combination of these variables.

API's estimates may differ from the results that would have been obtained if the entire industry, or a different group of companies, had participated in the survey. Table 8 gives the margin of error representing the 95-percent confidence interval for API's estimates—the range in which the actual value almost certainly lies. The probability is 95 percent that the true amount for the industry is within the range.

API estimated that, excluding remediation and spills, the entire industry's environmental expenditures were $7.276 billion in 1996. The margin of error for this estimate is plus or minus 2.5 percent. This means that API estimates with 95-percent certainty that expenditures were between $7.094 billion and $7.458 billion.

The model used to estimate these expenditures and margins of error assumes perfect accuracy in company responses. However, as with any survey, practical difficulties can also influence results and introduce errors. Of necessity, API's estimates are based on imperfect data. Many companies do not track environmental spending separately. Others categorize environmental spending differently from the survey. Consequently, some companies are only able to provide a best estimate of what they spend.

Table Notes

Tables showing 1990-1993 expenditures by sector and by medium can be found in the fourth edition of this publication. A similar table for 1994 can be found in the fifth edition.

In some cases, totals may not equal the sum of their components due to independent rounding.

Dollar amounts in all tables are not adjusted for inflation.

Tables 2, 5, 6, and 8 do not include expenditures for remediation and spills.

Participating Companies

Alamco, Inc.
Aleyska Pipeline Service Company
American Exploration Company
Amoco Corporation
Ashland Inc.
Atlantic Richfield Company
Bar-Mac Inv. Inc.
Barger Engineering, Inc.
Belle Fourche Pipeline Company
Berry Petroleum Company
BHP Petroleum (Americas) Inc.
Blue Dolphin Energy Company
BP America Inc.
Cenex, Inc.
Certified Oil Company
Charles B. Wilson, Jr., Inc.
Chermac Energy Corporation
Chevron Corporation
CITGO Petroleum Corporation
Coast Oil Company
Conoco Inc.
Consumers Gasoline Stations, Inc.
Croft Petroleum Company

Cross Oil Refining & Marketing, Inc.
Devon Energy Corporation
DOL Resources, Inc.
Elf Exploration, Inc.
Energy Pro, Inc.
Ergon, Inc.
Evergreen Resources, Inc.
Exxon Company, U.S.A.
Fina, Inc.
Giant Refining Company -- Bloomfield
Great Eastern Energy and Development Corporation
Great Western Drilling Company
H&C Oil Operating Inc.
H&D Operating Company
Haley Petroleum Inc.
Harold E. Bailey
Heartland Exploration Inc.
Hellman Properties LLC
Hull Oil Company
J.H. Booth, Inc.
J.W. Gibson
Jack L. Phillips Company
John H. Young, Inc.
Justiss Oil Company, Inc.
Karper Company, The
Ken Petroleum Corporation
Keoughan's Producing Company
Lakehead Pipe Line Company, Inc.
Lario Oil and Gas Company
Laurel Op. Company Inc.
Lone Mountain Prod. Company
Long Drlg. Company
Long Oil Company
Luff Exploration Company
Lynn Creek Oil Company
Mack Energy Corporation
Marathon Oil Company
McGowen Working Partners
Mesa Operating Company
Michael D. Lillis
Midco Exploration
Mixon Bros. Drilling, Inc.
Mobil Oil Corporation
MR Oil Company
Murphy Oil Corporation
Naval Petroleum Reserve No. 1
Occidental Oil and Gas Corporation
ONEOK Resources Company
Ouachita Exploration, Inc.
Oxy Chem Pipeline
Par-co Drilling, Inc.
Pennzoil Company
PEP Drilling Company
Phillips Petroleum Company
Pogo Producing Company
Powerine Oil Company
Presidio Exploration, Inc.
Reliable Oil Industries Inc.
Seagull Energy Corporation
Shell Oil Company
Star Enterprise
Statex Petroleum, Inc.
Steuart Petroleum Company
Stockdale Oil & Gas, Inc.
Sun Company, Inc.
Taurus Exploration, Inc.
Texaco Inc.
Texas Crude Operator, Inc.
Thums Long Beach Company
Tipperary Corporation
Tripledee Drilling Company
True Oil Company
Union Pacific Resources Company
United Refining Company
Unocal Corporation
Venada National
Westico Energy Company
Williams Pipe Line Company
Withrow Engineering/Precision Operating, Inc.
Wolf Creek Exploration Company
Woodyard Drilling
Woolsey Petroleum Corporation
Wynnewood Refining Company
X-L Energy Company

1 Total U.S. Environmental Expenditures: 1990-1996[1]

(in millions of dollars)

Category	1990	1991	1992	1993	1994	1995	1996
Ongoing activities	6,341	7,054	8,981	8,975	9,096	8,148	6,986
Research and development	175	227	214	227	175	156	103
Corporate programs	147	121	78	246	194	141	187
Subtotal	6,663	7,402	9,273	9,448	9,465	8,445	7,276
Remediation and spills	1,124	1,332	1,250	1,198	1,177	1,169	947
Total	7,787	8,734	10,523	10,646	10,642	9,614	8,222

[1] *All expenditures are estimated except for remediation and spills.*

2 Summary of Estimated U.S. Environmental Expenditures: 1990-1996

(in millions of dollars)

Sector	1990	1991	1992	1993	1994	1995	1996
Exploration and production:							
Capital	653	729	743	859	828	596	762
Operations, maintenance, and administration	872	824	823	704	731	726	820
Subtotal	1,525	1,553	1,566	1,563	1,559	1,322	1,582
Transportation:							
Capital	277	291	365	374	288	246	257
Operations, maintenance, and administration	389	446	601	598	584	563	757
Subtotal	666	737	966	972	872	809	1,013
Refining:							
Capital	1,286	1,809	3,282	3,215	3,118	2,158	826
Operations, maintenance, and administration	2,424	2,309	2,526	2,483	2,815	3,351	3,132
Subtotal	3,710	4,118	5,808	5,698	5,933	5,509	3,958
Marketing:							
Capital	229	329	366	395	393	211	165
Operations, maintenance, and administration	211	317	275	347	339	297	267
Subtotal	440	646	641	742	732	508	432
Research and development	175	227	214	227	175	156	103
Corporate programs	147	121	78	246	194	141	187
Grand total	6,663	7,402	9,273	9,448	9,465	8,445	7,276

3 Summary of Reported U.S. Environmental Expenditures on Remediation and Spills by Sector: 1990-1996

(in millions of dollars)

Sector	1990	1991	1992	1993	1994	1995	1996
Exploration and production:							
Remediation	82	78	84	114	128	162	146
Spills	50	39	28	22	21	26	18
Subtotal	132	117	112	136	148	188	164
Transportation:							
Remediation	39	35	51	55	65	95	80
Spills	47	42	50	53	39	48	24
Subtotal	86	77	101	108	104	143	104
Refining:							
Remediation	273	256	180	165	201	180	171
Spills	37	30	23	18	38	18	29
Subtotal	310	286	203	183	239	197	200
Marketing:							
Remediation	548	819	798	748	666	623	460
Spills	41	29	21	13	9	6	6
Subtotal	589	848	819	761	675	629	466
Research and development:							
Remediation	6	3	9	9	8	8	9
Spills	1	1	6	1	3	3	3
Subtotal	7	4	15	10	11	12	12
Grand total	1,124	1,332	1,250	1,198	1,177	1,169	947

4 Summary of U.S. Environmental Expenditures by Medium: 1990-1996

(in millions of dollars)

Year	Air	Water	Wastes	Other	Subtotal[1]	Remediation[2]	Spills[2]
1990	2,274	2,764	692	933	6,663	948	176
1991	2,962	2,612	785	1,043	7,402	1,191	141
1992	4,285	2,813	952	1,223	9,273	1,122	128
1993	4,539	2,622	902	1,385	9,448	1,091	107
1994	4,868	2,423	854	1,320	9,465	1,068	110
1995	4,564	1,915	720	1,245	8,445	1,068	101
1996	3,628	1,953	608	1,086	7,276	866	81

[1] *Includes expenditures for ongoing activities, research & development, and corporate programs.*

[2] *Aggregate of amounts reported by participants in API's survey.*

5 Estimated U.S. Environmental Expenditures by Medium: 1996

(in millions of dollars)

Sector	Air	Water	Wastes	Other	Total
Exploration and production:					
Capital	118	474	95	74	762
Operations, maintenance, and administration	104	323	113	280	820
Subtotal	222	797	209	354	1,582
Transportation:					
Capital	98	129	12	18	257
Operations, maintenance, and administration	97	231	36	393	757
Subtotal	195	360	48	410	1,013
Refining:					
Capital	614	159	34	21	826
Operations, maintenance, and administration	2,398	431	207	95	3,132
Subtotal	3,012	590	241	116	3,958
Marketing:					
Capital	36	101	12	15	165
Operations, maintenance, and administration	96	48	70	53	267
Subtotal	133	149	83	68	432
Research and development	41	17	11	33	103
Corporate programs	25	40	17	104	187
Grand total	3,628	1,953	608	1,086	7,276

6 Estimated U.S. Environmental Expenditures by Medium: 1995

(in millions of dollars)

Sector	Air	Water	Wastes	Other	Total
Exploration and production:					
Capital	73	379	90	54	596
Operations, maintenance, and administration	103	262	128	233	726
Subtotal	176	641	218	287	1,322
Transportation:					
Capital	123	80	3	40	246
Operations, maintenance, and administration	58	195	36	275	563
Subtotal	181	275	38	315	809
Refining:					
Capital	1,795	271	74	19	2,158
Operations, maintenance, and administration	2,173	543	273	362	3,351
Subtotal	3,968	814	346	381	5,509
Marketing:					
Capital	61	108	24	17	211
Operations, maintenance, and administration	73	40	62	122	297
Subtotal	134	148	86	140	508
Research and development	81	21	16	38	156
Corporate programs	24	16	17	84	141
Grand total	4,564	1,915	720	1,245	8,445

7 U.S. Market Share of Survey Participants: 1990-1996

Sector	1990	1991	1992	1993	1994	1995	1996
Exploration and production:[1]							
Upstream revenues (in dollars)	59%	61%	58%	62%	69%	63%	60%
Transportation:[2]							
Trunkline miles (in barrel miles)	74%	69%	71%	76%	70%	74%	63%
Refining:[3]							
Refinery operating capacity (in barrels per calendar day)	71%	73%	77%	77%	77%	72%	71%
Marketing:[4]							
Gasoline sales volumes (in gallons)	82%	85%	91%	93%	93%	97%	95%

[1] *Estimate based on API surveys and U.S. Department of Energy, Energy Information Administration, "Petroleum Supply Annual."*

[2] *Oil and Gas Journal, "Pipeline Economics."*

[3] *U.S. Department of Energy, Energy Information Administration, "Petroleum Supply Annual."*

[4] *U.S. Department of Transportation, Federal Highway Administration, "Monthly Motor Fuel Reported by States."*

8 Margins of Error in API Estimates: 1990-1996

(estimates in millions of dollars)

Year	Exploration and Production	Transportation	Refining	Marketing	R&D and Corporate Programs	Total
1990:						
Estimate	1,525	666	3,710	440	322	6,663
Margin of error	± 6.0%	± 1.8%	± 2.7%	± 1.8%	± 2.5%	± 2.0%
1991:						
Estimate	1,553	737	4,118	646	348	7,402
Margin of error	± 7.6%	± 1.4%	± 1.9%	± 1.5%	± 0.6%	± 1.9%
1992:						
Estimate	1,566	966	5,808	641	292	9,273
Margin of error	± 12.1%	± 6.8%	± 2.2%	± 5.9%	± 0.7%	± 2.6%
1993:						
Estimate	1,563	972	5,698	742	473	9,448
Margin of error	± 8.4%	± 8.3%	± 2.3%	± 8.9%	± 10.6%	± 2.3%
1994:						
Estimate	1,559	872	5,933	732	369	9,465
Margin of error	± 7.9%	± 6.8%	± 3.1%	± 7.4%	± 14.1%	± 2.5%
1995:						
Estimate	1,322	809	5,509	508	296	8,445
Margin of error	± 6.1%	± 3.3%	± 2.9%	± 1.3%	± 22.6%	± 2.3%
1996:						
Estimate	1,582	1,013	3,958	432	290	7,276
Margin of error	± 6.3%	± 5.0%	± 3.4%	± 0.9%	± 14.6%	± 2.5%

Petroleum Industry Environmental Performance
Sixth Annual Report

This report is part of achieving the objectives of STEP – Strategies for Today's Environmental Partnership. For more information about STEP, see page 4, or call API's STEP Coordinator at 202-682-8468.

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