Oil Refineries Fail to Report Millions of Pounds of Harmful Emissions

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Prepared for Rep. Henry A. Waxman

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EXECUTIVE SUMMARY

This report summarizes the findings of an investigation by the minority staff of the House Government Reform Committee into fugitive emissions from oil refineries. The investigation was requested by Rep. Henry A. Waxman, the ranking member of the Committee on Government Reform. It finds that (1) oil refineries vastly underreport leaks from valves to federal and state regulators and that (2) these unreported fugitive emissions from oil refineries add millions of pounds of harmful pollutants to the atmosphere each year, including over 80 million pounds of volatile organic compounds (VOCs) and over 15 million pounds of toxic pollutants. These emissions could be eliminated if refineries complied with the requirements of the Clean Air Act.

Oil refineries are one of the largest sources of air pollution in the United States. Refineries are the single largest stationary source of VOCs, the primary precursor of urban smog. Refineries are also the fourth largest industrial source of toxic emissions and the single largest industrial source of benzene emissions.

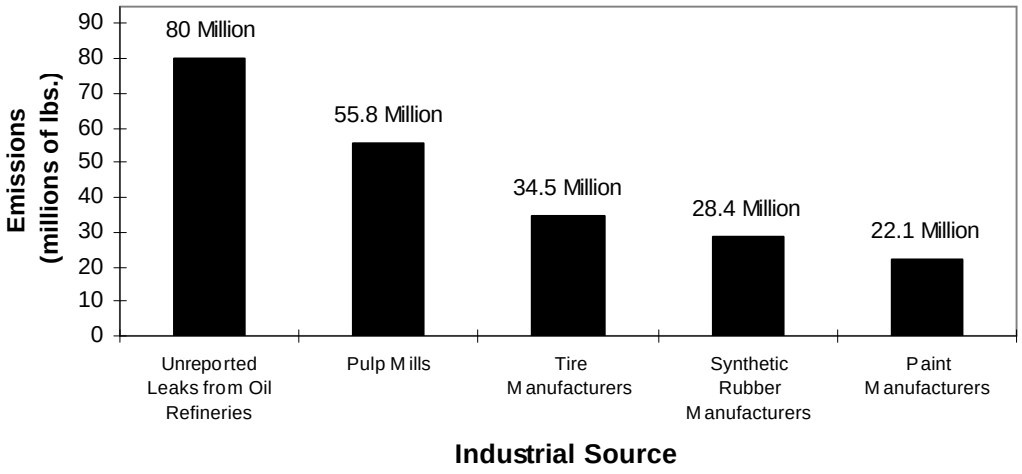
One of the major causes of air pollution at oil refineries is high levels of "fugitive emissions." Fugitive emissions are emissions from equipment leaks, such as valves, storage tanks, and other industrial equipment. In fact, over half of all reported VOC and toxic emissions from refineries are fugitive emissions.

This report on fugitive emissions from refineries is based on a review of enforcement records and other information obtained from the U.S. Environmental Protection Agency (EPA). These documents reveal that oil refineries fail to report large volumes of fugitive emissions. The average oil refinery reports to state and federal regulators that 1.3% of the valves at its facilities have leaks. In fact, the average leak rate from valves at oil refineries is 5.0% -- nearly four times higher than the average reported leak rate.

The failure to properly detect and repair leaking valves has a substantial adverse impact on air quality in the United States. At the request of Rep. Waxman, EPA has estimated that oil refineries are releasing at least 80 million pounds of undetected VOCs from leaking valves each year. These unreported fugitive emissions from refineries are the 11th largest industrial source of VOC emissions in the United States, exceeding the emissions of many other large industries, including pulp mills, tire manufacturers, and synthetic rubber manufacturers (Figure 1).

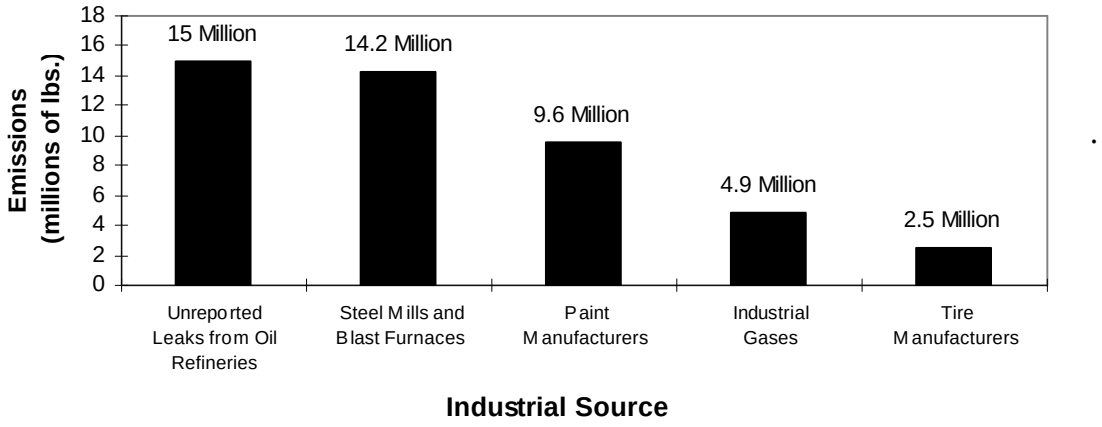
The state and local impacts of these emissions can be significant. Nearly half of the unreported fugitive VOC emissions are estimated to occur in areas that do not meet federal standards for urban smog. The emissions appear to be concentrated primarily in ten states: Texas, Louisiana, California, Illinois, New Jersey, Pennsylvania, Washington, Ohio, Indiana, and Oklahoma.

Figure 1: Emissions of VOCs for Selected Industries



The unreported fugitive emissions of other pollutants are also substantial. This report estimates that the 80 million pounds of unreported VOC emissions from oil refineries contain more than 15 million pounds of unreported toxic air pollutants, including over 1 million pounds of benzene. These unreported toxic air pollutants from refineries are greater than the toxic emissions from most industries in the United States, including the combined toxic emissions of steel mills and blast furnaces (Figure 2).

Figure 2: Emissions of Toxics for Selected Industries



Controlling these unreported fugitive emissions could be done at minimal cost. Often, all that is required is simply tightening a valve with a wrench. Under the Clean Air Act, leaking valves at oil refineries are supposed to be detected and repaired. If these requirements were met, the emissions reductions would be equivalent to removing the VOC exhaust emissions from five million new cars or eliminating the VOC emissions from 27,500 print shops.

I. OIL REFINERIES ARE A SIGNIFICANT SOURCE OF AIR POLLUTION

A. The Oil Refinery Industry

There were 164 petroleum refineries in operation in the United States in fiscal year 1998.[1] These refineries use physical, thermal, and chemical separation techniques to separate crude oil into several components, including fuel; nonfuel products such as solvents and asphalt; and chemical industry feedstocks such as benzene and propane.[2] Approximately 90% of the petroleum products produced in the United States are fuels.[3] Motor vehicle gasoline accounts for about 43% of the total output from refineries.[4]

These 164 refineries have an aggregate throughput capacity of 17,264,270 barrels per day, or 6.3 billion barrels per year.[5] A small number of large facilities refine most of the oil in the United States. In 1994, large facilities with a capacity over 50,000 barrels per day accounted for approximately half of all refineries in operation in the United States, but were responsible for 86% of the total crude distillation in the United States.[6]

The vast majority of oil refineries are located near crude oil sources or in heavily industrialized areas. For that reason, most oil refineries are located near East and West Coast population centers, along the Gulf Coast, or in the industrial Midwest. In 1998, there were 27 refineries in Texas, 24 in California, 20 in Louisiana, 6 in Pennsylvania, 6 in New Jersey, and 6 in Illinois.[7] Figure 3 shows the location of oil refineries in the continental United States.[8]

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[1]Letter from Steven A. Herman, EPA Assistant Administrator, to Rep. Henry A. Waxman (June 29, 1999) (hereafter "EPA letter").

[2]U.S. EPA, *Petroleum Refining Industry Sector Notebook* (Sept. 1995).

[3]*Id*.

[4]*Id.*

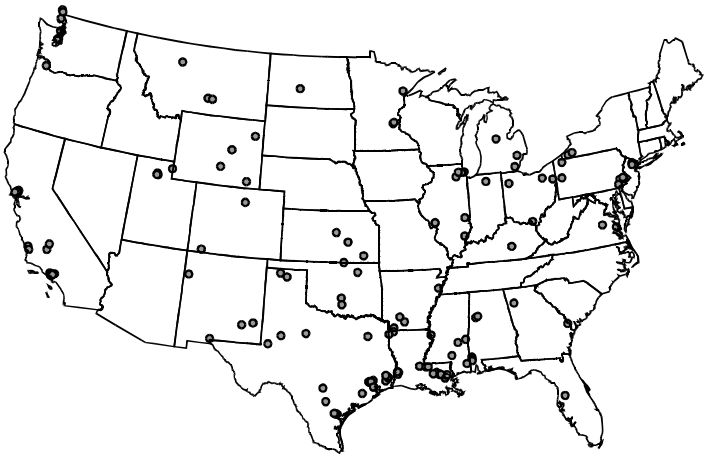
[5]EPA letter, enclosure 1, response 2.

[6]U.S. EPA, *Petroleum Refining Industry Sector Notebook* (Sept. 1995).

[7]EPA letter, table 4.

[8]Geography and Map Division, Library of Congress (Oct. 1999). The map excludes refineries located in Alaska, Puerto Rico, and the U.S. Virgin Islands.

Figure 3: Locations of Oil Refineries in Operation in the United States



Not surprisingly, air pollution is a significant problem in many of these states. In fact, over 40% of the oil refineries in the United States -- 66 out of 164 -- are located in "nonattainment" areas that do not meet federal air quality standards for one or more pollutants emitted in significant amounts from refineries.[9]

B. Air Pollution from Oil Refineries

1. Emissions of VOCs

Oil refineries are the largest stationary source of VOC emissions in the United States.[10] Emissions of VOCs react with nitrogen oxide (NOx) emissions in the presence of sunlight to form ground-level ozone, which is an invisible, toxic gas that is the primary ingredient of urban smog. High levels of smog have been linked to serious health problems, including irritation of the respiratory system and reduced lung function. Smog also aggravates preexisting respiratory diseases such as asthma.[11] Children, the elderly, and people with respiratory conditions are especially susceptible to ozone pollution.[12]

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[9]Appendix 2 lists the refineries operating in the United States in 1998 located in nonattainment areas for O_3, SO_2, or PM_{10}, and the pollutant for which the area was in nonattainment.

[10]EPA letter, enclosure 1, response 6.

[11]EPA, *Smog: Who Does It Hurt?* (July 1999).

[12]*Id.*

According to EPA's Aerometric Information Retrieval System (AIRS) database, oil refineries release approximately 246,069 tons (492 million pounds) of VOCs each year.[13] This represents over 11.4% of all stationary emissions of VOCs included in the AIRS database.[14] In fact, oil refineries release more than twice as many VOCs as the next highest sector, organic chemical plants.[15]

The major source of VOC emissions at oil refineries is fugitive emissions. Fugitive emissions at oil refineries come from a number of sources, including leaking valves, pumps, seals, connectors, pressure relief devices, and storage tanks. According to EPA, more than half of oil refinery emissions are fugitive emissions.[16]

2. Emissions of Toxic Air Pollutants

Oil refineries are one of the major sources of toxic air emissions in the United States. Air pollutants are considered "toxic" when they have the potential to cause serious adverse health effects, such as cancer, neurotoxicity, or reproductive toxicity. Examples of these toxic air pollutants include benzene, a known human carcinogen, and xylenes, which depress the central nervous system, damage the kidneys, and irritate the respiratory system.

In 1997, refineries reported releasing over 58 million pounds of toxic air pollutants.[17] Overall, according to the Toxic Release Inventory (TRI), oil refineries were the fourth largest industrial source of toxic air pollutants.[18] Refineries are the largest industrial source of air emissions of benzene (emitting over 2.9 million pounds), the second largest of xylenes (4.2 million pounds) and methyl ethyl ketone (4.1 million pounds), and the third largest industrial source of air emissions of toluene (7 million pounds).[19] Oil refineries are also significant sources

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[13] *Id.* The AIRS database may actually underestimate emissions from refineries. This data is collected by state and local enforcement agencies. According to a report by the EPA Inspector General, many significant air pollution violations went undetected by the states or unreported to EPA. Letter from Steven A. Herman, EPA Assistant Administrator, to Rep. Henry A. Waxman (June 29, 1999).

[14] EPA letter, enclosure 1, response 6.

[15] *Id.*

[16] *Id.*

[17] EPA, *1997 Toxic Release Inventory* (April 1999).

[18] *Id.* The three industries ranked ahead of petroleum refiners were pulp mills, industrial organic chemical production, and primary non-ferrous metal production.

[19] *Id.*

of a number of other toxic air pollutants, including ethylbenzene, 2,2,4-trimethylpentane, hexane, cresols, MTBE, napthalene, and phenol.[20]

These toxic air pollutants can have both chronic and acute health impacts on a large number of exposed individuals. For example, in 1995, EPA estimated that 4.5 million individuals living within 30 miles of oil refineries were exposed to benzene at concentrations that posed cancer risks that were higher than the Clean Air Act's acceptable risk threshold. The maximum risk for individuals exposed to benzene from oil refineries was 180 times higher than the acceptable risk threshold.[21]

The majority of toxic pollutants from oil refineries are released as fugitive emissions.[22] According to TRI data, oil refineries reported releasing 31 million pounds of toxic fugitive emissions in 1997 -- more than half of the 58.7 million pounds of toxic air pollutants released from refineries that year.[23]

3. Emissions of Other Pollutants

In addition to VOCs and toxic pollutants, oil refineries are a significant source of a number of other air pollutants regulated by EPA. Oil refineries are the second largest industrial source of sulfur dioxide (SO_2) emissions,[24] which lead to the formation of acid rain; the third largest industry sector source of nitrogen oxides (NO_x) emissions,[25] which contribute to the formation of acid rain and combine with VOCs in the presence of sunlight to form ozone; and the fourth largest industry sector source of primary particulate matter (PM) emissions,[26] which are associated with numerous adverse health effects, including premature death, increased respiratory symptoms and disease, and decreased lung function.

EPA estimates that each year oil refineries also emit almost 35 million pounds of

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[20]EPA, *National Emission Standards for Hazardous Air Pollutants: Petroleum Refineries; Final Rule*, 40 CFR Part 9, 60, and 63, 43245 (Aug. 18, 1995).

[21]EPA, *Regulatory Impact Assessment for the Petroleum Refinery NESHAP: Revised Draft for Promulgation*, 211-212 (July 1995).

[22]EPA letter, enclosure 1, response 6.

[23]EPA, *1997 Toxic Release Inventory* (April 1999).

[24]EPA letter.

[25]*Id.*

[26]*Id.*

methane.[27] Methane is a potent greenhouse gas that has a global warming potential 21 times that of carbon dioxide (CO_2).[28] In 1996, methane emissions accounted for 10% of domestic greenhouse gas emissions -- second only to CO_2 emissions.

II. OIL REFINERIES ARE UNDERREPORTING FUGITIVE EMISSIONS

A. The Requirements of the Clean Air Act

Because of the prominent role of fugitive emissions at oil refineries, EPA has promulgated extensive regulations under the Clean Air Act to control emissions from leaking valves. These regulations are called the Leak Detection and Repair (LDAR) rules. They require the implementation of work-practice standards aimed at detecting and repairing leaks. LDAR rules have been incorporated into a number of EPA Clean Air programs, including state implementation plans to meet National Ambient Air Quality Standards (NAAQS), New Source Performance Standards (NSPS), and National Emissions Standards for Hazardous Air Pollutants (NESHAP).[29]

Under the LDAR rules, a leak is typically defined as a release of more than 10,000 parts per million (ppm) of VOCs or other pollutants measured at the valve.[30] The rules require refineries to: (1) identify regulated equipment; (2) monitor regulated equipment to detect leaks above the established standards; and (3) repair or replace leaking equipment.[31] The specific requirements, such as what constitutes a leak or monitoring frequency, vary somewhat in stringency among different programs and states.[32]

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[27]EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-1997*, 2-30, Table 2-27 (converted from million metric ton carbon equivalent (MMTCE)).

[28]*Climate Change 1995 – The Science of Climate Change, IPCC Second Assessment Report*. New research from the World Meteorological Organization indicates that methane's global warming potential may be as high as 24 times that of CO_2. Global Ozone Research and Monitoring Project, World Meteorological Organization, *Scientific Assessment of Ozone Depletion*, vol, 2, Report No. 44, 10.27, Table 10-8 (1998).

[29]On August 18, 1995, EPA promulgated the final NESHAP for oil refineries. While the data analyzed for this report was collected in 1998 -- before the new NESHAP rule was fully implemented -- the new rule largely incorporated existing LDAR requirements.

[30]40 CFR 60.482.

[31]EPA letter, enclosure 1, response 7.

[32]*Id.*

Under these rules, refineries generally must monitor for leaks from many industrial components each quarter. If a leak is detected, the equipment must be repaired "as soon as practicable, but no later than 15 calendar days after the leak is detected."[33] This repair is often as simple as tightening the valve with a wrench. In some instances, the leak will require a more extensive repair, such as replacing the packings used in the valve. If the repair or replacement is not technically feasible without a process unit shutdown, the repair or replacement must be completed by the end of the next scheduled process unit shutdown.[34] Refineries that detect leak rates under 2% are permitted to monitor at less frequent intervals.[35] As a result, the problem of inadequate leak detection is compounded if a facility erroneously reports a leak rate under 2%, because the facility is then allowed to skip required monitoring.

B. Reported and Actual Leak Rates

EPA's National Enforcement Investigations Center has been inspecting oil refineries for the past several years for fugitive emissions, particularly from leaking valves. At the request of Rep. Waxman, the minority staff obtained the results of these inspections from EPA. These results show that there is widespread and substantial underreporting of leaks by the oil industry.

In total, EPA has inspected 117 process units at 17 refineries. Ten of these investigations have been completed and seven are currently under review. The facilities that were inspected ranged in size from a small refinery with a capacity of 36,000 barrels per day to a very large refinery with a capacity of 410,000 barrels per day. The number of valves in the process units monitored during each inspection ranged from 2,229 to 42,505 valves per facility.[36]

The EPA inspection reports show that the leak rates at each inspected facility were significantly higher than the leak rates reported to state and federal regulators by the facilities themselves. These refineries have a total of 170,717 valves. The facilities reported leaks from 2,266 valves, which is a leak rate of 1.3%. EPA inspectors, however, monitored 47,526 valves at those facilities and found leaks in 2,373 valves (see Figure 4).[37] This is a leak rate of 5.0% -- nearly four times higher than the leak rates reported by the refineries. Although the EPA investigators inspected only 25% of the total number of valves at these refineries, they found leaks in more valves than the total number of leaks reported by the refineries themselves.

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[33] 40 CFR 60.482.

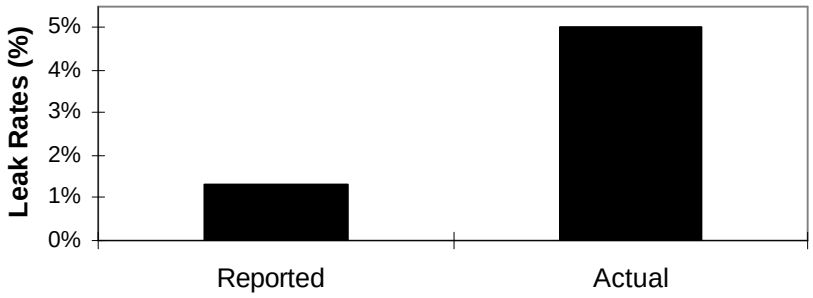
[34] *Id.*

[35] *Id.*

[36] EPA letter, enclosure 1, response 9.

[37] *Id.*, table 6A and 6B.

Figure 4: Actual Refinery Valve Leak Rates Are Substantially Higher Than Industry Reports Indicate



For the ten facilities at which investigations have been completed, the refineries reported leak rates (measured by the number of leaking valves divided by the total number of valves at the facility) of between 0.2% and 3.6%. The EPA investigations, however, found leak rates that ranged from 1.7% to 10.5%. The highest leak rate was detected at the Chevron refinery in Richmond, California. That refinery reported detecting leaks at only 179 out of 7,694 valves at the facility -- a leak rate of only 2.3%. EPA monitored 3,363 valves at the facility and found leaks in 354 valves -- a leak rate of 10.5%.[38]

The biggest variance between reported and actual leak rates occurred at the Ashland refinery in Canton, Ohio. The refinery reported detecting leaks from only nine out of 5,339 valves at the facility -- a leak rate of 0.2%. EPA monitored 2,754 valves at the facility and detected leaks in 84 valves -- a leak rate of 3.1%. This means that estimated leaks at the refinery were more than 15 times higher than the number of leaks reported by the company.[39]

For the seven ongoing investigations, refineries reported leak rates of between 0.2% and 2.38%. EPA estimates, however, that the actual leak rates range from 2.8% to 11.5%. Because these are open investigations, the names and locations of the refineries were not provided to the minority staff. The highest leak rate was detected at a refinery that reported leaks at only 40 out of 4,160 valves -- a leak rate of 0.96%. EPA inspectors, however, detected leaks at 222 out of 1,926 monitored valves at the facility -- a leak rate of 11.5%. The biggest variance between reported and EPA monitored leaks occurred at a facility that reported a leak rate of only 0.2% -- 25 out of 12,686 valves. EPA detected leaks in 125 out of 3,228 valves -- a leak rate of 3.8%, or

[38] *Id.*, table 6A.

[39] *Id.*

19 times higher than the rate reported by the facility.[40]

EPA found similar results at each of these refineries.[41] Appendix 1 shows each facility inspected by EPA; the total number of valves at each facility; the number of leaks and the leak rates reported by each facility; the number valves inspected by EPA; and the number of leaks and the leak rates found by EPA.

III. UNREPORTED FUGITIVE EMISSIONS HAVE A SUBSTANTIAL IMPACT ON AIR POLLUTION

The widespread failure of oil refineries to comply with LDAR programs as required by the Clean Air Act is a major source of air pollution. Unreported fugitive emissions from leaking valves are estimated to add over 80 million pounds of VOCs into the atmosphere each year. This is an average of nearly two tons of additional VOCs from each refinery in the United States every day. These unreported fugitive emissions also include significant quantities of toxic pollutants.

A. Unreported VOC Emissions

At Rep. Waxman's request, EPA used its monitoring data at the 17 refineries to estimate the amount of unreported fugitive emissions from oil refineries. Based on data reported by the 17 facilities, EPA calculated that the refineries are reporting releasing an average of 69.3 pounds of fugitive VOCs per hour per facility.[42] EPA inspectors, however, found significantly higher leak rates from valves than reported by the facilities. Using these actual leak rates, EPA estimated that actual hourly emissions are nearly 2.5 times higher than reported by the facilities: an average of 163 pounds of fugitive VOCs per hour per facility.[43] This is equivalent to nearly two tons per day.[44] Based on these emissions rates, EPA estimated that refineries are emitting at

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[40] *Id.*, table 6B.

[41] EPA's findings are also consistent with independent audits conducted since 1994 by the South Coast Air Quality Management District of seven refineries in Southern California. Those audits found that actual leak rates were three times higher than the average leak rates reported by the refineries. South Coast Air Quality Management District, *Memorandum from Mohsen Nazemi to Barry Wallerstein* (November 5, 1999).

[42] EPA letter, enclosure 1, response 10.

[43] *Id.*

[44] The average release is estimated at 163 pounds per hour. Refineries operate an average of 8,000 hours per year. Total releases would be 652 tons per year, or 1.78 tons per day.

least 80 million pounds of unreported fugitive VOCs each year from leaking valves.[45] These unreported fugitive emissions are equal to over 30% of the reported fugitive VOC emissions and over 15% of all reported VOC emissions from oil refineries.

The total amount of unreported VOC emissions from oil refineries may be substantially higher than the 80 million pounds estimated by EPA. EPA's estimate is based solely on unreported leaks from valves. It does not take into account any unreported leaks from other sources, such as pumps or compressor seals. Moreover, EPA's estimate only included refineries larger than the smallest refinery investigated by EPA. It did not include unreported fugitive emissions from dozens of small refineries.[46]

Considered as their own source category, these unreported fugitive VOC emissions from leaking valves would be the 11th largest industrial source of VOC emissions in the United States.[47] Figure 1 compares the unreported fugitive VOC emissions from refineries with the VOC emissions from other sources.

The unreported fugitive VOC emissions from refineries are greater than the reported VOC emissions from most other industrial sources in the United States. They exceed the VOC emissions from pulp mills and are more than twice the VOC emissions from tire manufacturers.[48] In fact, the unreported fugitive VOC emissions from refineries exceed the VOC emissions of 347 of the 357 industries included in the AIRS database and are equal to the total combined emissions from more than two-thirds of the industrial sources included in the database.[49]

The unreported fugitive VOC emissions can have a significant impact on state and local air quality. The minority staff has made a preliminary estimate of emissions by state based on the throughput capacity at each refinery. It appears that nearly half of these unreported fugitive VOC emissions -- approximately 39 million pounds -- occur in areas that are not meeting federal air quality standards for ozone. As shown in Table 1, ten states would appear to be most heavily affected. These ten states are estimated to be responsible for over 75% of the unreported fugitive

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[45]EPA letter, enclosure 1, response 10.

[46]*Id.*

[47]EPA, *AIRS Database*, www.epa.gov/airs (Oct. 21, 1999).

[48]*Id.* According to the AIRS database, pulp mills release 27,921 tons (55.8 million pounds) of VOCs per year; tire and inner tube manufacturers released 17,235 tons (34.5 million pounds) of VOCs per year.

[49]*Id.*

VOC emissions.[50]

Table 1: States Most Affected by Unreported Fugitive VOC Emissions

State	Estimated Unreported VOC Emissions (lbs.)
Texas	19,861,000
Louisiana	12,763,000
California	9,039,000
Illinois	4,688,000
New Jersey	3,531,000
Pennsylvania	3,473,000
Washington	2,790,000
Ohio	2,318,000
Indiana	2,030,000
Oklahoma	1,928,000
Total for Top Ten States	**62,421,000**

The air pollution caused by the 80 million pounds of unreported VOCs is preventable. Under the LDAR rules, all detected leaks must be repaired. Thus, under these rules, oil refineries would be required to control these additional emissions if they detected and reported them. In many cases, this can be as simple as tightening a valve with a wrench. Removing the 80 million pounds of unreported VOCs from the air would be equivalent to eliminating VOC exhaust emissions from five million new cars.[51] It would also be equivalent to eliminating VOC emissions from 27,500 printing shops.[52]

B. Unreported Toxic Emissions

Unreported fugitive emissions also present a significant problem because they contain toxic air pollutants. According to EPA data, every 100 pounds of VOC emissions from refineries typically contains 19 pounds of toxic emissions.[53] This means that the 80 million pounds of

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[50]These estimates assume that individual refineries emit unreported fugitive emissions in proportion to their throughput capacity.

[51]According to EPA's Office of Mobile Sources, model year 2000 cars driven the average 14,910 miles per year emit 0.008 tons -- 16 pounds -- of VOCs from tailpipes each year.

[52]EPA estimate (Oct. 27, 1999).

[53]*See National Emission Standards for Hazardous Air Pollutants: Petroleum Refineries; Final Rule*, 40 CFR Part 9, 60, 63 (Aug. 18, 1995) (460,000 tons of VOC emissions contain

unreported VOC emissions from leaking valves are likely to contain over 15 million pounds of toxic air pollutants.[54] These emissions are likely to include over one million pounds of benzene, over 2.1 million pounds of xylene, and over 2.4 million pounds of toluene.[55] The 15 million pounds of unreported toxic emissions are equal to more than 25% of the 58.7 million pounds of total toxic emissions reported by refineries in 1997.

As shown in Figure 2, these unreported fugitive toxic emissions from leaking valves at oil refineries are greater than the toxic emissions from many industrial sources in the United States.[56] For example, the unreported fugitive toxic emissions from refineries exceed the combined toxic emissions from steel mills and blast furnaces.[57] Considered as their own source category, these unreported fugitive toxic emissions from leaking valves would be the 18th largest industrial sources of toxic emissions in the United States. The unreported fugitive emissions from refineries exceed combined releases from more than half of the 524 industries reporting in the TRI.[58]

Like the unreported fugitive emissions of VOCs, the unreported fugitive emissions of toxic pollutants are likely to be concentrated in ten states. Table 2 shows the estimated level of the unreported fugitive toxic emissions from refineries in these states.

Table 2: States Most Affected by Unreported Fugitive Toxic Emissions

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89,000 tons of toxic air pollutants).

[54]This calculation assumes that the composition of emissions from leaking valves is similar to the composition of overall emissions. In this case, if refineries are emitting 80 million pounds of unreported fugitive VOCs annually from leaking valves, the quantity of toxic air pollutants emitted by refineries is equal to 80,000,000 multiplied by 0.19, which is 15.2 million pounds of toxic air pollutants.

[55]Benzene, toluene, and xylene account for 7%, 16%, and 14%, respectively, of toxic air pollutants from refineries. J.F. Durham, EPA, Office of Air Quality, citing *112(k) Inventory -- Petroleum Refineries* (June 18, 1997).

[56]EPA, *1997 Toxic Release Inventory* (April 1999). Blast furnaces and steel mills reported releasing a combined total of 14.2 million pounds of toxic emissions.

[57]*Id.*

[58]*Id.* Primary aluminum smelters reported releasing 13 million pounds of toxic emissions.

State	Estimated Unreported Toxic Emissions (lbs.)
Texas	3,749,000
Louisiana	2,409,000
California	1,706,000
Illinois	885,000
New Jersey	666,000
Pennsylvania	655,000
Washington	527,000
Ohio	438,000
Indiana	383,000
Oklahoma	364,000
Total for Top Ten States	**11,782,000**

The 15 million pounds of unreported fugitive toxic emissions are preventable. If the refineries reported and repaired their leaking valves as required by the Clean Air Act, these emissions would be controlled. Removing these 15 million pounds of toxics from refineries from the air would be equivalent to eliminating toxic exhaust emissions from 1.1 million new cars.[59]

[59]EPA estimate (Oct. 6, 1999).

Appendix 1: Leak Rates at Refineries Inspected by EPA

Refinery	Reported Results			Inspection Results		
	# of Valves	# of Leaks	Leak Rate	# of Valves	# of Leaks	Leak Rate
Completed Investigations						
Chevron (Richmond, CA)	7,694	179	2.3%	3,363	354	10.5%
Exxon (Benicia, CA)	7,879	223	2.8%	3,407	216	6.3%
Star Enterprise (Delaware)	14,370	226	1.6%	3,852	236	6.1%
Shell (Wood River, IL)	3,913	22	0.6%	2,008	108	5.4%
AMOCO (Texas City, TX)	20,719	736	3.6%	3,351	179	5.3%
BP (Marcus Hook, PA)	5,555	96	0.67%	2,109	112	5.3%
Ashland (Canton, OH)	5,339	9	0.2%	2,754	84	3.1%
Ashland (Catlettsburg, KY)	8,374	78	0.9%	2,981	55	1.8%
ARCO (Los Angeles, CA)	42,505	124	0.29%	3,053	53	1.7%
Chevron (Pascagoula, MS)	2,229	26	1.2%	1,784	24	1.35%
Ongoing Investigations						
Refinery A	4,160	40	0.96%	1,926	222	11.5%
Refinery B	6,997	101	1.4%	1,658	114	6.9%
Refinery C	7,181	112	1.6%	2,897	130	4.5%
Refinery D	8,532	203	2.38%	4,060	181	4.5%
Refinery E	5,944	29	0.49%	2,487	106	4.3%
Refinery F	12,686	25	0.2%	3,228	125	3.8%
Refinery G	6,640	36	0.5%	2,608	74	2.8%
Total	**170,717**	**2,266**	**1.3%**	**47,526**	**2,373**	**5.0%**

Appendix 2: Oil Refineries in Nonattainment Areas for O_3, SO_2, or PM_{10}

State	Refinery Name and Location	Nonattainment for:
California	Anchor Refining Co. - McKittrick	O_3, PM_{10}
cCCal		
California	Atlantic Richfield Co - Carson	O_3, PM_{10}
Californiaaaa		
California	Chevron USA - El Segundo	O_3, PM_{10}
California	Chevron USA - Richmond	O_3
California	Equilon Enterprises LLC - Bakersfield	O_3, PM_{10}
California	Equilon Enterprises LLC - Wilmington	O_3, PM_{10}
California	Equilon Martinez Refinery Co - Martinez	O_3
California	Exxon Co - Benicia	O_3
California	Golden Bear Oil Specialties - Oildale	O_3, PM_{10}
California	Huntway Refining Co - Benicia	O_3
California	Huntway Refining Co - Wilmington	O_3, PM_{10}
California	Kern Oil & Ref. - Bakersfield	O_3, PM_{10}
California	Mobil Oil Corp - Torrance	O_3, PM_{10}
California	Paramount Petroleum Corp - Paramount	O_3, PM_{10}
California	San Joaquin Refining Co Inc - Bakersfield	O_3, PM_{10}
California	Santa Maria Refining Co - Santa Maria	O_3
California	Ten By Inc - Oxnard	O_3
California	Tosco Refining Co - Los Angeles (Carson and Wilmington)	O_3, PM_{10}
California	Tosco Refining Co - San Francisco (Avon, Rodeo, and Santa Maria	O_3
California	Ultramar Diamond Shamrock Corp - Wilmington	O_3, PM_{10}
California	World Oil Co - South Gate	O_3, PM_{10}
Colorado	Conoco Inc - Commerce City	PM_{10}
Colorado	Ultramar Diamond Shamrock Corp - Denver	PM_{10}*
Delaware	Motiva Enterprises LLC - Delaware City	O_3
Georgia	Young Refining Corp - Douglasville	O_3
Illinois	Citgo Petroleum Corp - Lemont	O_3
Illinois	Clark Ref. & Mktg. - Hartford	O_3
Illinois	Clark Refining & Marketing - Blue Is.	O_3
Illinois	Mobil Oil - Joliet	O_3
Illinois	Wood River Ref. Co - Wood River	O_3
Indiana	Amoco Oil Co - Whiting	O_3, SO_2, PM_{10}
Kentucky	Marathon Ashland Petroleum LLC - Catlettsburg	SO_2
Louisiana	Exxon Co - Baton Rouge	O_3
Louisiana	Placid Refining Co - Port Allen	O_3
Montana	Cenex - Laurel	SO_2
New Jersey	Amerada Hess Corp - Port Reading	O_3
New Jersey	Chevron USA Products Co - Perth Amboy	O_3
New Jersey	Citgo Asphalt Ref. Co - Paulsboro	O_3
New Jersey	Coastal Eagle Point Oil Co - Westville	O_3

New Jersey	Tosco Refining Co - Linden	O_3
New Jersey	Valero Energy Corp - Paulsboro	O_3
State	**Refinery Name and Location**	**Nonattainment for:**
Ohio	BP Oil Co - Toledo	SO_2
Ohio	Sun Company Inc - Toledo	SO_2
Pennsylvania	Sun Company Inc - Marcus Hook	O_3
Pennsylvania	Sun Company Inc - Philadelphia	O_3
Pennsylvania	Tosco Refining Co - Trainer	O_3
Pennsylvania	United Refining Co - Warren	SO_2
Texas	Amoco Oil Co - Texas City	O_3
Texas	Chevron USA Products Co - El Paso	O_3, PM_{10}
Texas	Clark Refining & Marketing - Port Arthur	O_3
Texas	Crown Central Petroleum Corp - Pasadena	O_3
Texas	Exxon Co. USA - Baytown	O_3
Texas	Fina Oil & Chemical Co - Port Arthur	O_3
Texas	Lyondell Citgo Refining Co - Houston	O_3
Texas	Marathon Ashland Petroleum LLC - Texas City	O_3
Texas	Mobil Oil Corp - Beaumont	O_3
Texas	Motiva Enterprises LLC - Port Arthur	O_3
Texas	Phillips Petroleum Co - Sweeny	O_3
Texas	Shell Deer Park Refining Co - Deer Park	O_3
Texas	Specified Fuels & Chemicals LLC - Channelview	O_3
Texas	Valero Energy Corp - Houston	O_3
Texas	Valero Energy Corp - Texas City	O_3
Utah	Amoco Oil Co - Salt Lake City	SO_2, PM_{10}
Washington	Sound Refining Inc - Tacoma	PM_{10}
Washington	US Oil & Refining Co - Tacoma	PM_{10}
West Virginia	Ergon-West Virginia Inc - Newell	SO_2, PM_{10}

*EPA has proposed designating Denver as a nonattainment area for O_3.