CONTROL OF AIR TOXICS: A PRELIMINARY ECONOMIC ANALYSIS

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PREFACE

The Clean Air Act, the primary federal statute controlling air pollution in the United States, was last amended in 1977. Recently, a comprehensive set of amendments was approved by the Senate Subcommittee on Environmental Protection. The five titles of the proposed bill would address compliance with the national ambient air quality standards for ozone; limit emissions of pollutants causing acid rain; impose new controls on mobile sources of air pollution; redefine units of measurement for the national ambient air quality standards; and limit routine and accidental emissions of air toxics.

This staff working paper considers the potential economic effects of Title V of the proposed amendments, designed to control routine and accidental emissions of toxic air pollutants. This paper was prepared at the request of Senators Bingaman, Boren, Byrd, Cochran, Conrad, Dixon, Ford, Garn, Gramm, Hatch, Heflin, Helms, Lugar, McConnell, Murkowski, Nickles, Pressler, Pryor, Quayle, Rockefeller, Sanford, Shelby, Simpson, Stevens, Symms, Trible, Wallop, and Warner. In keeping with the mandate of the Congressional Budget Office (CBO) to provide objective analysis, the report makes no recommendations.

Sharon H. Stahl of CBO's Natural Resources and Commerce Division wrote the report under the supervision of Roger C. Dower and Everett M. Ehrlich. Bob Friedman of the Office of Technology Assessment, Jim McCarthy of the Congressional Research Service, and Michael Shapiro of the Environmental Protection Agency provided valuable assistance and comments. The paper was edited by Francis S. Pierce, and the manuscript was typed and prepared for publication by Patricia Z. Joy.

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SUMMARY

Title V of the proposed Senate bill to amend the Clean Air Act establishes a regulatory program to control routine and accidental emissions of toxic air pollutants from a wide variety of industrial and mobile sources. Whether these provisions can achieve cost-effective health and environmental improvements is uncertain. Thus, the Congress faces a fundamental (and increasingly common) trade-off concerning the control of toxic air pollutants in evaluating this bill. On one hand, it can act now to reduce perceived health and environmental risks, but at some risk of misallocating health and environmental resources. On the other hand, delays in imposing federal controls on these emissions may result in continued threats to health and the environment.

The purpose of this preliminary assessment is to identify and evaluate the major characteristics of the air toxics problem that would appear to determine the economic trade-offs associated with selected provisions of Title V. The paucity of reliable data on emissions of air toxics and the costs of the abatement activities required by the bill, coupled with wide possible variations in health and environmental risk reductions, limit the degree to which a definitive assessment can now be conducted. It is possible, however, to highlight those aspects of the proposed bill that are likely to be most important in terms of the ultimate level of costs and benefits.

Emission Reductions and Benefits

The benefits of the proposed bill are a function of the reduction in emissions of air toxics resulting from the bill's implementation. The lack of a data base containing current emissions of air toxics makes it difficult to estimate the emissions reductions resulting from Title V. In this study, volatile organic compounds (VOC) emissions--some of which are a subset of all air toxic emissions--are considered rough proxies for emissions of air toxics. It is estimated that approximately 1.4 million tons emitted by major point sources and 3 to 6 million tons emitted by area sources may be controlled as a result of the bill's technology-based standard and area source reduction requirements. These estimates depend, however, on several factors. For example, since small point or area sources contribute approximately 87 percent of all VOC emissions, Title V's area source provisions might be expected to result in greater emissions reductions. But area source reduc-

tions of VOCs would also occur in response to Titles I and III of the bill, independently of Title V. In addition, further emission reductions can also be expected from both point and area sources as a result of other existing and proposed federal and state programs. The result of these and other features of air toxic control is to complicate the estimation of potential emissions abatement associated with the the bill's control provisions and, therefore, the resulting benefits.

Control Costs

Uncertainty also characterizes the estimation of costs. Some VOC (and other air toxics) control technology is already in place as a result of other federal and state regulations, although the degree of control varies from state to state and from industry to industry. Without detailed information on current plant-level controls, compliance costs for Title V can only be crudely approximated over a rather large range.

This analysis estimates the costs of the Section 502 technology-based standards at between $2.1 billion and $13.8 billion per year. This includes approximately $690 million to $2.8 billion in annual compliance costs to be incurred by major point sources, and $1.4 billion to $11 billion in other area source reductions. The large range is a direct function of the uncertainty concerning the unit costs of control and the current inventory of emissions. For example, the costs of the area source reduction requirements (55 percent of the national inventory of air toxic emissions over a 10-year period) are likely to be at the low end of the range (or even zero) if current and planned EPA programs achieve their anticipated reductions. On the other hand some area source reductions will probably be required under the technology-based standard requirements.

There is even greater uncertainty concerning the costs of the Section 503 health-based standards. These are intended to be more stringent than the technology standards but to apply to a much smaller set of substances and facilities. There is, however, some question as to whether these provisions would require EPA to do anything more than under its current obligations. Alternatively, one interpretation of this section would require EPA to set what have in the past been very expensive standards.

Finally, the cost to industry of conducting the hazard assessments required by Title V Section 507 can also vary, depending on the number of covered chemicals and facilities, and the number of hazard assessments expected to be performed by each facility. For example, this analysis estimates the annual cost associated with conducting the hazard assess-

ments biennially over 10 years to range from $86 million for 20 chemicals to $1.7 billion if hazard assessments were required for all 402 chemicals potentially covered by this section.

Policy Observations

As outlined above, the annual costs of Sections 502 and 507 of Title V are estimated to range from $2.1 billion to $16.0 billion, with the high estimate based on a strict interpretation of the Title and upper-bound estimates of control costs. Uncertainty as to emissions levels, control costs, and chemical coverage complicates the estimation, as does possible assignment of costs to other proposed Titles and current programs. Without corresponding estimates of potential benefits, it is difficult to judge the reasonableness of the estimated costs. In terms of the value of shipments represented by the affected industrial sources, these costs are quite small. The estimated costs appear larger, however, compared to industrial expenditures on current air pollution control programs, which were estimated to be around $23 billion (in 1984 dollars) in 1981.

In spite of the substantial difficulty surrounding estimation of Title V costs and benefits, some general observations concerning the bill's policy trade-offs can be made:

- Insufficient information is available concerning the level and distribution of toxic air emissions to allow accurate assessment of the costs and benefits of the Title V technology-based standards provisions. Some relevant data on emissions and potential exposures are expected to be received by EPA beginning in July of 1988 as a result of Superfund requirements. This information would reduce the uncertainty surrounding the location and quantity of toxic emissions and the related effects on human health. Analysis of this data might allow the development of technology-based standards that maximize risk reduction by more closely targeting specific sources responsible for these human health risks;

- Many states have programs in place or are developing programs to address the hazards presented by emissions of air toxics. It is unclear to what degree these programs, along with current federal regulatory efforts, have already controlled hazardous releases, and to what extent they will continue to do so without additional intervention. Existing state programs contain many of the elements prescribed by the Title V provisions, however. It is possible that these programs, with EPA assistance, could achieve

the reductions in toxic emissions that are called for in Section 502. An investigation of the success of these programs, and other associated federal and state efforts, in reducing toxic emissions could narrow the range of potential control costs and benefits associated with Title V;

- Area sources appear to be responsible for most of the exposures resulting from air toxics, and therefore may present the greatest potential for risk reduction. As area sources tend to be numerous and small, enforcement of area source controls would be difficult. Also, control costs vary significantly for area sources. Further analysis of releases from specific area sources and of the efficacy and cost of area source reductions might provide additional insight on cost-effective control measures;

- Small businesses and farms could bear a large share of the burden of performing hazard assessments assuming full implementation of Section 507. Although the cost of conducting one hazard assessment may be fairly small, the burden would increase with the number of covered chemicals handled at each facility. Costs could be contained by excluding farms and facilities employing fewer than 10 workers from Section 507 coverage. Under current Superfund law, local committees must plan for accidental releases. The information provided by the hazard assessments could aid these committees in their emergency preparedness activities by providing the location of potential releases and distribution of exposures. To the extent that the hazard assessment requirements overlap with the Superfund community right-to-know programs, both the costs and benefits of the emergency release provisions would be reduced.

OVERVIEW OF TITLE V PROVISIONS

Toxic air pollutants are chemicals in the air that present a threat to public health and the environment.[1/] For the purpose of Section 502 of Title V, toxic air pollutants include air pollutants subject to the requirements of SARA Title III, Section 313, and other pollutants on the list published under Section 104(i)(2)(A) of the Comprehensive Environmental Response,

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1. Toxic air pollutants are sometimes distinguished from other air pollutants that may also involve health risks, by reference to their potential for chronic health risks from long-term, low-level exposure.

Compensation and Liability Act of 1980 (CERCLA). The EPA Administrator is also required to add chemicals to the list of covered air toxics upon a showing by a petitioner that a substance causes or may be reasonably anticipated to cause adverse effects on human health or the environment. Excluding possible administrative additions, the bill would cover approximately 329 chemicals from SARA Section 313, and 100 additional chemicals from CERCLA. Of these, 240 are estimated by EPA to be toxic air pollutants. Air toxics covered under Section 507 of Title V, concerning the prevention of sudden, catastrophic releases, include substances that are reasonably anticipated to cause acute adverse health effects, and are to be drawn from, but are not limited to, the list of those substances established by Section 302 of SARA, Title III. This list currently includes 402 hazardous substances.

The Title V air toxic control provisions require that industrial, commercial, and mobile sources reduce their routine emissions of air toxics and take steps to reduce the health risks of accidental releases. These two major sections (Sections 502 and 507) of the bill's provisions are the focus of this report. Although there are many other sections of the Title, in general they support these two activities. Further, the routine and accidental release provisions are likely to involve the highest compliance costs. A complementary review of the Title V requirements has been conducted by the Congressional Research Service. 2/

Routine Emission Controls

Under the Title V provisions, all potential sources of air toxic emissions are divided for regulatory purposes into two main groups depending, in general, on the level of emissions. These are:

- Major stationary point sources--those facilities that emit or have the potential to emit five tons per year or more of any air pollutant or 25 tons or more of any combination of toxic air pollutants; and

- Area sources--any stationary or mobile source that is not a major source, such as drycleaners or automobiles.

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2. J.E. McCarthy and M. Simpson, *Hazardous Air Pollutants: An Analysis of Title V of the Proposed Clean Air Act Amendments*, Congressional Research Service, 87-770 ENR (September 1987).

Under Section 502, major point sources would be subject to nationally uniform technology-based standards to be established by EPA for groups of industries. The standards are to reflect the best available control technology, taking into consideration the cost of achieving such emissions reduction. 3/

In addition to the technology standards, major sources of air toxics may also be subject to health-based standards under Section 503, if EPA determines that the technology standards are not adequate to protect public health. The bill is unclear as to the operational threshold for adequate protection. One possible interpretation would require EPA to set health-based standards if maximum individual risk of cancer from exposure to a substance exceeds one in one million. Unlike the technology-based standards, the health-based standards cannot take into account the costs of compliance.

The bill is less specific with regard to routine area source controls, requiring only that emission levels from these sources be reduced by set percentages according to a timetable set in the statute. The actual methods for achieving these reductions are subject to EPA discretion. Control programs regulating major point sources are to be implemented through state permit programs.

Accidental Releases

The accidental release provisions of Title V attempt to minimize the potential health and environmental effects of air toxic releases resulting from, for example, equipment failures or other industrial accidents (such as those that have occurred in Bhopal, India, and Institute, West Virginia). The basic approach of the bill is to make available to the public information concerning the types of air toxics handled by firms at specific sites and the various contingencies surrounding their potential release.

Every firm handling any substance listed by EPA above a certain threshold amount is required to conduct a hazard assessment for the chemical or chemicals. The hazard assessment is required to include basic

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3. Technology-based standards are to be phased in according to a specified compliance schedule, with emission standards for all categories of sources becoming effective not later than 10 years after the bill's enactment.

data on the facility, facility processes, population, and meteorology of the area, potential sources of release, and information on previous releases. In addition, it must supply data on size, concentration, and duration of potential releases; the probability and magnitude of exposure; a review of various release prevention measures; and an analysis of the assumptions underlying the hazard assessment. These are to be made available to the public, and to state and local agencies to assist in emergency planning.

COSTS AND BENEFITS

This cursory overview suggests several categories of direct costs and benefits that might be expected to result from the Title V provisions. In general, the direct costs to firms of the two major toxic air control programs evaluated here include the costs to major point and area sources of installing the required technology controls; the possible costs of meeting more stringent health-based standards; the costs of conducting hazard assessments; and the costs that would occur if hazard assessments prompted state or federal action to further reduce the probability of a release. Other costs that might be incurred by industry include the cost of complying with permitting requirements, responding to release prevention regulations, and monitoring toxic air releases. The potential costs to federal, state, and local governments include the cost of promulgating rules, conducting health assessments (as performed by EPA, to be distinguished from hazard assessments performed by industry), developing state air toxic control programs, creating the Chemical Safety and Hazards Investigation Board, and all other associated administrative costs.

The potential benefits of the direct control portions of the proposed legislation include the value of reductions in adverse health effects associated with lower current and future toxic emissions (including reduced mortality and morbidity as well as other health outcomes) and the value of reducing the adverse environmental effects of toxic air emissions. Benefits associated with the hazard assessment provisions are somewhat less direct and flow from, in theory, the ability of the hazard assessments to reduce adverse health effects by helping facility owners/operators to identify and mitigate potential avenues of toxic releases and by providing public information of release risks. Other sections of Title V have even less well-defined benefits, although not necessarily less important. These might include, for example, more timely and accurate information on chemical risks and therefore, in theory, better targeted regulations and reduced health and environmental risks.

The actual costs and benefits that would result from the proposed legislation are a function of a wide range of variables that include the level of control obtained, the rigidity of the technology-based standards, and the types of health effects that are associated with the controlled chemicals. Of course, these concerns affect virtually every economic analysis of environmental rulemaking. Analysis of the air toxic provisions in Section 502 of Title V, however, is distinguished by several major characteristics of the problem that may be more pronounced for air toxic regulation than for other environmental hazards. These are:

- o The existence of ongoing federal and state programs designed to control air toxics or related air pollutants; and

- o The quantity of air toxics currently emitted by major point and area sources and their regional concentration.

These characteristics of the problem of air toxics control are considered in more detail below.

Current Federal, State, Local, and Private Control Actions

Actions that federal, state, and local governments, as well as private companies, have already taken to control air toxics determine to a significant degree the potential for future emissions reductions and the costs of achieving these reductions. The Clean Air Act Amendments of 1970 created 247 Air Quality Control Regions across the nation and required the EPA to set standards for all *criteria* pollutants, a category that now includes particulates, carbon monoxide, sulfur oxides, nitrogen dioxide, ozone, and lead. State governments were given responsibility for setting individual standards for existing polluters, but the federal government dictates the goals in the form of national ambient air quality standards. The EPA can declare a region in nonattainment of standards for one or more pollutants, and require sources in that region to install more stringent control technology. In order to comply with those regulations, states develop implementation plans that specify the manner in which existing pollution sources will adopt *reasonably available* control technology and the method that new pollution sources will use to achieve the *lowest achievable* emission rates. In attainment areas, new sources must install *best available* control technology.

The national ambient air quality standards for ozone (for which VOCs are precursers) and particulates (which are often associated with many toxic metals), together with state implementation plans, regulate indirectly

emissions of toxic air pollutants. Many major industrial point sources of VOCs and particulates have already installed reasonably available control technology. Further, Titles I and III of the Senate bill will result in new VOC controls in attainment areas and air transport regions. Everything being equal, these actions limit the potential for further emission reductions from the proposed Title V controls and raise the unit cost of achieving those reductions.

Additional control of toxic air pollutants can be credited to the National Emissions of Hazardous Air Pollutants (NESHAP) Program established by EPA under Section 112 of the 1970 Clean Air Act Amendments. Section 112 is the EPA's regulatory authority for air toxics, which mandates standards based solely on human health considerations. EPA's implementation of Section 112 has been slow, however. Since 1970, only seven substances have been regulated, which implies that the NESHAP standards have probably not resulted in significant across-the-board air toxics reductions.

State efforts to control toxic air pollutants are also under way. A survey conducted in 1983 by the State and Territorial Air Pollution Program Administrators and the Association of Local Air Pollution Control Administrators indicated that 19 states had air toxics control programs in place, and that 23 were developing programs. Twenty-seven of those states were developing emissions inventories at the time of the study, and most state programs reported that they operated or planned to operate a permit system to regulate emissions of air toxics. Ambient standards for air quality as well as technology-based standards for point sources are used by states to control toxic emissions, with risk assessment techniques being employed to target carcinogens for regulation. Some states with active regulatory programs may require that firms install best-available control technology to control emissions of specific air toxics. While many states have the programs in place to control emissions of toxic air pollutants, most are newly established and there is little evidence yet as to the success of their effort. Finally, firms are facing growing incentives, in an effort to reduce their corporate liability, to conduct assessments of potential hazards from toxic chemical releases and to initiate inspections and preventive maintenance activities.

The efforts by federal, state, and local governments and private industry to control toxic emissions suggests that the baseline from which one should measure emission reductions resulting from Title V is not an uncontrolled state. Although uncertain, the current levels of control for VOCs, particulates, and other air toxics are greater than zero. This raises the question of the potential for further cost-effective reductions in

pollution emissions by major point sources. One EPA document attempting to assess the degree to which current policy has controlled toxic releases reports that reductions in emissions of toxic metals from point sources are generally high, ranging from 80 percent to 98 percent, while reductions for organic compounds are somewhat less--from 30 percent to 90 percent. A second study estimates a 30 percent to 70 percent reduction in metallic particulates, and a 10 percent to 80 percent control of 15 chemicals in the chemical industry. [4]

Current Emissions of Air Toxics

No published data base exists for levels and sources of emissions of the chemicals covered by the proposed Title V. [5] Thus, little is known about the total quantity of these chemicals emitted, where they are emitted, and who or what may be exposed to them. Emission data on VOCs are available, however. VOCs are a subset of the toxic constituents covered by Title V, although not all VOCs would be subject to the bill's provisions. The National Emissions Data System (NEDS) managed by the EPA contains inventories of VOC emissions based on plant-level data submitted by the states. NEDS excludes facilities emitting less than 100 tons of the criteria pollutants from its point source file. A facility that emits more than 100 tons of any one of the criteria pollutants, however, will have all its emissions captured in the point source file. Since sources emitting between 5 tons and 100 tons are defined as point sources under the bill, the NEDS data underestimate point source emissions that may be subject to the technology-based standards in the bill. On the other hand, 5-to-100-ton sources are included as area sources of VOC emissions in NEDS. It is not possible at this time to determine the affected number of facilities and quantity of emissions in the 5-to-100-ton category.

The composition of measured VOCs varies from industry to industry, and it is not known how many of the toxic chemicals covered by Title V are included in estimates of VOC emissions. Further, it is not clear how closely VOC emissions correlate with toxics. In addition, some toxic metals may be emitted as particulate matter. NEDS data on particulate emissions are

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4. Environmental Protection Agency, *The Magnitude and Nature of the Air Toxics Problem in the United States*, draft report (September 1984).

5. Some survey data may be available from a House subcommittee. This has not been investigated for this study.

reported here (even though these emission estimates are not used in the formal analysis) in order to illustrate the potential regional distribution of non-VOC toxic emissions.

Table 1 summarizes total U.S. emissions of VOCs. Approximately 19 million tons of VOCs were emitted by major point and area sources in 1985. Area sources account for almost 87 percent of total VOC discharges, with mobile sources being the major contributor. Industrial processes, primarily in organic chemical manufacture and petroleum refining, are responsible for just over 43 percent of point source emissions, as shown in Table 2.

The pattern of VOC emissions varies from state to state. As shown in Table 3, five states--Illinois, Indiana, Louisiana, Tennessee, and Texas--account for over 40 percent of all toxic emissions from point sources. This is due primarily to the concentration of heavy industrial sources in some of these states. Another 20 percent are emitted by facilities in five states: California, Michigan, Missouri, Ohio, and Virginia. Exposures to VOCs from point sources are evidently concentrated in the Midwest, South, and West.

The pattern of area sources of VOCs appears to follow centers of population as well as industrial concentration, with the most area source VOCs being emitted in California, New York, and Texas, followed by Ohio, Pennsylvania, Illinois, and Florida. Emissions of particulates are distributed across states differently from VOCs, but also vary widely. Sources in Colorado, Illinois, Missouri, Ohio, and Texas account for approximately 54 percent of all particulates emitted by point sources.

The VOC and particulate emission data tell us something about the potential overall toxic air emissions and their possible regional distribution. Even these data are uncertain, however. For example, another EPA publication, *National Air Quality and Emissions Trends*, places 1985 VOC emissions from industrial processes at 8.5 million metric tons as compared with the approximately 1 million tons reported in the NEDS data base. The estimate of 8.5 million tons extrapolates from aggregate U.S. production and consumption data, while NEDS is a combination of plant-level data and estimates based on plant submissions. Most of the difference between the two data sources, however, probably results from different definitions of area and point sources.

This discussion of air toxic emissions data, as measured by VOC and particulate data, is significant in terms of what is known and not known about current emission levels that would serve as a baseline for estimating potential reductions from the Title V requirements. Although no reliable

data exist on all air toxic emissions, the analysis of VOC and particulate emissions presented here suggests that toxic air emissions are likely to vary dramatically by region and industrial category. Therefore, a given source control technology might result in very different levels of risk reduction depending on the type of source and where the source is located.

ESTIMATED COSTS OF THE MAJOR TITLE V PROVISIONS

This analysis estimates direct compliance costs for two components of Title V:

- The potential costs to industry of complying with the technology-based standards and area source emissions reductions outlined in Section 502 (as demonstrated by VOC control costs); and

- The cost to facilities performing hazard assessments as required by Section 507 on the prevention of sudden, catastrophic releases.

In addition, the possible costs associated with Section 503 health-based standards are also investigated. All of these costs, of course, even if estimated accurately, would tend to underestimate the total costs of the bill given its other requirements. Further, these costs should be considered first-order effects in that they do not reflect the ultimate social costs of the proposed bill.

Costs of the Technology-Based Standards

The cost to a facility of reducing VOC emissions (or any other type of pollution) can vary significantly depending upon the level of emissions, the abatement technology, and the level of control already achieved. In general, the higher the level of control, the greater the cost of achieving further reductions. More specialized (and expensive) technology is often required to reduce emissions from 70 percent to 95 percent, than is required to attain 10 percent to 70 percent reductions. Various estimates of VOC control costs (in 1986 dollars per ton reduced) are listed in Table 4. They range from a low of -$490 in current dollars cited by the Office of Technology Assessment to a high of $9,225 reported by Robert Crandall in *Controlling Industrial Pollution.* (The negative estimate is a result of the potential for cost savings associated with materials recovery for some processes.) The Environmental Protection Agency has quoted a range of

$500 to $5,000, with an average of about $2,000 per metric ton.[6] Some of these estimates are probably not directly comparable since they refer to different types of technology controls representing different levels of stringency.

As illustrated in Table 5, control costs are likely to vary across industrial sectors. For example, some motor vehicle controls may be relatively inexpensive, while small dry cleaning establishments could incur significant costs (on a per-ton basis) if they were required to reduce their VOC emissions. Even within a particular industry, control costs can vary from plant to plant, depending upon factors such as facility size. Estimates of control costs for particulates ranging from $0 to $147,056 per metric ton are reported in Table 6.

The potential control costs associated with regulations designed to meet the health-based standards required by Section 503 of Title V will also have a large variance. The key assumption underlyling the costs of the Section 503 requirement concerns the extent to which the proposed health-based standards language will force EPA to act differently than it would under Section 112 of the current Clean Air Act. Some analysts argue that the requirements of the two sections are essentially the same and that the lack of any action-forcing language in Title V means that no new programs or standards will have to be developed. This would suggest that no new costs would be associated with this section. On the other hand, an alternative interpretation of the bill's language would suggest that EPA is required to set health-based standards whenever it determines that a substance presents a maximum individual risk of cancer greater than 10^{-6} after all affected facilities have come into compliance with the Section 502 technology standards. Only a few of the health-based standards currently in place control cancer risks to this level and the unit control costs tend to be relatively high. For example, Table 7 presents selected estimates of compliance costs resulting from EPA regulations under Section 112 of the CAA. Thus, it is plausible that the unit costs of complying with health-based standards are higher than those associated with the technology-based controls.[7]

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6. Meeting with EPA officials, September 1987.

7. The health-based standards cannot be set with regard to costs. In addition, the health-based standards are invoked only after the technology standards are found to be insufficient.

The actual costs of the Section 503 rules will probably lie somewhere between the two extremes. While the Title V requirements may put additional pressure on EPA to speed up its promulgation of health-based standards, the statute places some limits on how fast the agency has to move and the number of standards that it has to consider at any one time. Further, it appears that the bill provides EPA with the flexibility to target the highest-risk sources within specific industrial categories, rather than setting uniform category standards. But if EPA should have to set standards that are protective up to 10^{-6}, the costs to the targeted sources could be quite high. In either case, it would appear unlikely that the cost of this section would be zero unless it has no effect above that which could be required under current law.

Major Point Source Controls. Table 8 provides a range of estimated costs to major point sources (with emissions of over 100 tons) of complying with the technology-based standards required in Section 502 of Title V. The estimated annual cost ranges from $690 million based on unit costs of $500 per ton, to $2.8 billion using unit costs of $2,000 per ton. The actual control costs for industrial categories subject to Title V technology standards are likely to vary within this range depending on the degree of control already attained and the particular control technology required. For example, although Table 5 suggests that the petrochemical industry has achieved its current level of control with per-ton costs at the low end of the range, it is likely that as higher level of emissions reductions are sought, per-ton costs will rise. Actual control costs also will vary by plant location; for example, the EPA analysis of Title V assumes that facility control costs will average $500 in attainment areas and $2,000 in nonattainment areas, presumably because point sources in nonattainment areas must pursue a greater control efficiency.

The estimated emission reductions, also shown in Table 8, assume a current control efficiency of 85 percent for the organic and inorganic chemical industry, and 75 percent for all others.[8/] The imposition of new control technology is assumed to achieve a total of 90 percent control efficiency in all industries. Thus, a rough attempt has been made in this analysis to estimate costs and emission reductions after the imposition of Title I controls that require the installation of less stringent technology standards on VOC sources in some areas of the country than those mandated by Title V.

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8. EPA's analysis of Title V suggests that 75 percent is a reasonable estimate of RACT control efficiency. An analysis of OTA's industry-specific control efficiencies indicates that some industries, particularly the chemical industry, are achieving a higher level of control.

The estimates of control costs in Table 8 must be viewed with caution. While it is likely that the actual costs of compliance will be within the estimated range, there is little basis, at this point, for determining where in the range. Besides the uncertainty associated with the specific unit (per ton) control costs, little is known about industry-specific control technologies and resulting emission levels. There is little doubt, however, that some industry categories will be able to achieve reductions at substantially lower costs than others. Further, not all VOCs will require Section 502 controls. On the other hand, no cost estimate for non-VOC toxic emission controls has been included. In addition, this analysis employs a data base that treats facilities emitting between 5 tons and 100 tons of VOCs annually as area sources of emissions. Since these firms are defined as major point sources by the bill and made subject to technology-based standards, the cost of this section of the bill could be underestimated. A simple extrapolation of VOC control costs to all air toxics could be misleading, since it is uncertain whether VOC emissions can serve as a proxy for all air toxics.

Area Source Controls. Title V Section 502 calls for the reduction of area source emissions by 55 percent over a 10-year period. Area sources as described in Title V include (but are not limited to) degreasing and solvent cleaning operations, dry cleaners, pesticide applications, wood combustors, other small combustion units, gasoline marketing, mobile sources, and materials transportation. Area source emissions, as given in NEDS, are listed in Table 1. If the baseline inventory for Title V reductions includes VOC emissions from all area sources, 1985 area source emissions totalled approximately 16.7 million tons. According to the bill, 55 percent of this total, or approximately 9.1 million tons, must be controlled. Alternatively, EPA has estimated area source VOC emissions for selected sources mentioned in the bill, excluding pesticide applications and materials transportation, at 11.3 million tons. If this emissions estimate is considered as the baseline for future reductions under Title V, approximately 6.2 million tons would remain to be controlled.

The Office of Technology Assessment has estimated that some VOC emissions reductions will be achieved by sources complying with Titles I and III. It calculates that 3.5 million tons of VOC emissions will be eliminated by the installation of reasonably available control technology on stationary sources, additional controls on gasoline volatility, and enhanced inspection and maintainence programs. 9/ The stationary sources expected to incur

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9. The emissions reduction required of some stationary sources by Title I must occur only five months out of the year. The OTA estimates are on an annual basis, implying that actual reductions will be less than reported here.

these control costs include plants in the following industries: petroleum refining, certain types of chemical manufacturing, paper surface coating, automobile surface coating, gasoline terminals, service stations, and dry cleaning.

If 3.5 million tons of VOCs are controlled by the provisions of Titles I and III, emission reductions of 5.6 million tons (9.1 million tons minus 3.5 million tons) of the high-end inventory of VOCs remain to be achieved by area sources complying with Title V Section 502 reduction requirements. Using the EPA VOC emissions estimate, 2.7 million tons of area source emissions must be controlled.

It is unclear whether the existing federal and state VOC and mobile source regulatory programs, or the controls mandated by Section 502 of Title V, can achieve the required area source reductions. If emissions from autos and small facilities are already highly controlled, or are highly controlled after compliance with other Titles, further reductions may not be necessary to meet the 55 percent reduction requirement. If, on the other hand, the potential remains for significant emission reductions, costs will be associated with this requirement.

The per-ton cost to small facilities of going from reasonably available control technology (as specified by Title I and Title III) to the level of control required to meet Title V's area source reductions is difficult to estimate precisely, but is likely to be higher than the unit cost associated with lower levels of control. Using the same range of control costs employed in the major point source cost calculations, the estimated annual cost of controlling area source VOC emissions is shown in Table 9. The high estimate assumes the full NEDS inventory estimate of area source emissions, which also assumes no future reductions in VOC emissions from current or planned EPA programs. The low estimates are based on EPA's inventory estimate.

It is unlikely that no reduction in VOC emissions from area sources will occur as current and planned EPA programs take effect. In fact, if, as EPA claims, 6 million tons of VOCs will be controlled as a result of Titles I and III, the cost of area source reductions could be insignificant. Given the difficulty associated with predicting future reductions, this analysis adopts the base-line of no future emissions control above the 3.5 million ton reductions calculated by the Office of Technology Assessment. To the extent that current and future EPA programs reduce emissions by more than the 3.5 million tons, these areas source controls are overestimated.

The high cost estimates of the VOC area source emissions reductions required by Title V (net of Title I reductions), range between $2.8 billion, based on a cost of $500 per ton, and $11 billion, based on a cost of $2,000 per ton. Using the EPA VOC emissions inventory, control costs for area sources at a cost of $500 per ton would be $1.4 billion, and at $2,000 per ton would be $5.4 billion.

The degree of uncertainty implicit in this analysis is reflected in the wide range of estimated costs. Unit control costs, baseline emissions from area sources, and the effect on area source emissions of Title I and Title III provisions are all subject to some uncertainty. As mentioned previously, it is also likely that some of these area sources will qualify as major point sources under the bill. This would presumably result in a transfer of some area source control costs to the major source control cost category.

Estimated Costs of Hazard Assessment Requirements

The cost to industry of conducting hazard assessments depends upon the number of chemicals subject to the assessment requirements, the number and size of facilities handling those chemicals in quantities greater than the threshold amount, and the cost per hazard assessment. An EPA regulatory impact analysis performed in support of regulations under Title III of the Superfund Amendments and Reauthorization Act provides a basis for estimating both the number of covered facilities and hazard assessment costs. 10/

In this study, EPA presents an estimate of the number of facilities that handle the 402 extremely hazardous chemicals in quantities greater than calculated threshold planning quantities. The threshold planning quantities (TPQs) were determined for each substance based on its relative toxicity and tendency to become airborne. Chemicals of lowest concern were assigned a TPQ of 10,000 pounds. Between the limits of one pound and 10,000 pounds, chemicals were assigned to intermediate categories based on differing levels of concern. A total of 1,362,151 facilities were estimated to handle the 402 extremely hazardous chemicals in excess of the TPQs established by EPA. This number includes 438,576 small firms, 149,244 medium/large firms, and 774,331 farms.

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10. *Regulatory Impact Analysis in Support of Rulemaking Under Sections 302, 303 and 304 of Title III of the Superfund Amendments and Reauthorization Act of 1986*, prepared by Michael Shapiro and Renee Rico, Office of Toxic Substances, EPA, April 1987.

The same regulatory impact analysis calculates the cost to a local emergency planning committee of conducting a vulnerability analysis assessing the likelihood of a release, and a risk analysis assessing the consequences of a release in a community. The costs EPA has associated with each of these activities are the basis for the fixed and variable costs assumed to be incurred by a facility conducting a hazard assessment. These detailed costs are available upon request. As seen in Table 10, a small facility or a farm would spend an estimated $4,500--each being assumed to have only one covered substance on site, and therefore to conduct only one hazard assessment. Medium/large facilities, on the other hand, are assumed to handle four extremely hazardous substances on the average, and this, along with higher fixed costs per site, explains the estimated facility cost of $21,083. The assumption of four chemicals per site derives from an EPA analysis of the chemicals covered under Section 313 of SARA.[11/] Given these assumptions, if hazard assessments were required to be performed for all 402 chemicals, the annual cost over 10 years to affected facilities could exceed $1.7 billion dollars.

Title V gives EPA the authority to select the chemicals that will be subject to Section 507. Because it is highly unlikely that hazard assessments will be required of all 402 chemicals, cost estimates for smaller groups of covered chemicals are also provided in Table 10. These costs assume that the same number of small, medium/large, and farm facilities per chemical will be expected to conduct hazard assessments. If facilities handling only 20 extremely hazardous substances were required to conduct hazard assessments, the total one-time cost would be approximately $428 million, or $86 million annually. The number of hazard assessments performed will depend primarily on the number of facilities subject to this requirement. It is possible that in choosing the chemicals to be subject to the hazard assessment provisions, EPA would attempt to minimize the burden to small affected parties by excluding those compounds commonly handled, for example, by farmers. If farmers were exluded, aggregate costs associated with conducting hazard assessments as listed in Table 10 could fall by approximately 40 percent. An additional 23 percent could be saved by limiting Section 507 coverage to facilities employing 10 or more workers.

The actual unit assessment cost faced by firms will be dependent on EPA's implementation of these provisions. $4,500 may over- or underesti-

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11. *Regulatory Impact Analysis in Support of Proposed Rulemaking Under Section 313 of the Superfund Amendments and Reauthorization Act of 1986*, prepared by Debra Harper, Office of Toxic Substances, EPA, May 1987.

mate the cost of a hazard assessment. For example, if small facilities are not required to collect data on demographics or resort to modeling the geographic dispersion of accidental releases, $4,500 may be a reasonable, or even high, estimate. Further, it is possible that major chemical companies would be required to conduct more than four hazard assessments, and would therefore incur per-facility costs higher than those presented in Table 10. Finally, it is difficult at this point to know how the per-unit assessment costs will vary given the final assessment requirements. Some analysts claim that many facilities already conduct hazard assessments, presumably because the private benefits of doing so (including reduced liability) are greater than the costs. They have also commented, however, that the requirements for probability calculations in the assessments could substantially increase their costs over that which they currently incur.

Comparison with EPA Analysis

EPA has estimated the cost to industry of complying with the Title V technology-based standards of Section 502, the health-based standards of Section 503, and the release prevention provisions of Section 507. Enough is known about the EPA methodology to make a rough comparision between its cost estimates and those presented here.

Estimates of 1985 VOC and particulate emissions were obtained by EPA from the National Emissions Data System (NEDS). Sources were excluded from the analysis if they emitted less than a combined total of 25 tons of VOCs and particulates. The NEDS data base also contains information on control efficiencies associated with various industrial processes. The analysis of costs employed by EPA uses these control efficiencies to estimate the emissions reductions that might be expected from technology that controls between 75 percent and 95 percent of uncontrolled emissions. The analysis also excludes industry groups for which no process codes are available.

Section 502's technology-based standards are estimated by EPA to cost between $311 million and $1.38 billion, net of $1 billion assigned to Title I costs. Both VOC emissions and particulate emissions are assumed to be a subset of the air toxics covered by Section 502. The cost of abating VOCs accounts for $300 million to $825 million of EPA's total Section 502 costs, and between $11 million to $562 million is ascribed to particulate control costs.

The EPA analysis estimates that VOC control in attainment and nonattainment areas will cost $500 per ton and $2,000 per ton, respectively.

This derives from the assumption that little abatement technology has been installed in attainment areas so that emissions reductions that are achieved there will be the most cost-effective. Sources in nonattainment areas are expected to have already imposed reasonably available control technology, so that additional reductions in air toxics will be obtained at a higher cost per ton. Particulate emissions are estimated by EPA to cost between $35 per ton and $1,000 per ton to control. While the range of desired control efficiencies explains the range of costs associated with the abatement of VOC emissions, both the range of control efficiencies and the range of unit particulate control costs explain the $11 million to $562 million estimate associated with particulate control.

CBO estimates that the cost to major point sources of complying with Section 502 of Title V would be between $690 million and $2.8 billion. This range is based on the range of control costs that are applied to national point source VOC emissions--$500 and $2,000. Different control costs are not assigned to sources in attainment and nonattainment areas. Instead of using source-specific control efficiencies to determine the potential for emissions reduction as EPA does, this paper assumed that most major industrial emitters of VOCs have abated 75 percent of uncontrolled emissions. Installation of best available control technology is then expected to control an additional 15 percent of uncontrolled emissions. Thus, the EPA estimates are more likely to incorporate variation in technology and control effectiveness across industry categories. The major reason for the higher estimates of this paper appears to be that it used a larger base of emissions for the analysis than did EPA.

Another major difference between the EPA's and this paper's cost analysis concerns estimates of area source control costs. Specifically, the EPA analysis of the cost to area sources of VOC controls assumes that the existing and proposed regulations governing mobile source emissions will result in a reduction of approximately 50 percent of total mobile source emissions or about 4 million tons. This, along with the additional area source reductions in VOC emissions from Titles I and III, will achieve the level of control required by Title V. Therefore, EPA concludes that the cost associated with the area controls is zero.

This analysis suggests that the reductions associated with Title I and Title III may not satisfy the Title V area source requirements. If this is the case, the additional cost to be incurred by area sources of VOC emissions is estimated to range from $1.4 billion based on $500 per ton control cost and a low emissions estimate, to $11 billion based on $2,000 per ton control cost and a high estimate of emissions. It is possible that some of these area

sources are facilities large enough to be subject to the major point source provisions of Title V. To the extent that this is true, the cost of technology-based controls for major point sources will rise as both the emissions base and required level of control increase, while the area source control costs will fall.

EPA's analysis of Title V, Section 503, indicates that the cost of complying with the proposed health-based standards will be $3.3 billion, which is 66 percent to 87 percent of the estimated total cost of all Title V provisions. Current EPA proposed health-based regulations controlling emissions from coke ovens reduce the risk to the individual with maximum exposure to less than one in a thousand, not one in a million as prescribed in Title V. EPA's costs reflect the additional controls that will need to be applied to coke ovens and boilers. EPA estimates that even with the maximum degree of control of emissions that can be obtained by these sources, the health-based standard will still not be met. Although no attempt was made here to predict which sources and pollutants will be subject to these provisions, the EPA analysis demonstrates a point made earlier, that if a 10^{-6} standard is applied, the costs of Section 503 could be substantial. Total costs could be limited, of course, by targeting sources and thus limiting the number of tons of emission to be reduced. Unit control costs are still likely to be high for the targeted sources, and nothing in the bill limits the economic impact that can be imposed by EPA.

The annual costs associated with the Title V Section 507 release provisions were calculated by EPA to be between $170 million and $270 million. The lower cost is based on 25,000 medium/large facilities conducting assessments that cost $20,000 each. The higher figure assumes these assessments cost $40,000 each. Hazard assessments at 70,000 small facilities were assumed to cost $5,000 each. The number of covered facilities was estimated by using New Jersey survey data on 159 chemicals and extrapolating to the number of facilities nationwide handling at least one of any larger number of chemicals. This number was then scaled back to calculate the number of facilities handling 20 chemicals. To approximate the cost of biennial updates over 10 years, annual costs were calculated by doubling one-time costs and amortizing over 10 years.

The annual cost of conducting hazard assessments for 20 chemicals is estimated here to be $86 million (see Table 11). The major difference between this estimate and EPA's is that fewer facilities are expected to be affected than estimated by EPA, and the cost per assessment is lower.

ESTIMATED BENEFITS OF THE TITLE V PROVISIONS

The benefits of the technology-based and health-based standards controlling toxic air emissions are the reductions in health and environmental risks associated with the reduced emissions. It is not possible within the scope of this analysis to estimate the reductions in risk quantitatively. EPA, however, has made two estimates of the annual cancer incidence associated currently with air toxics exposure. These estimates might be construed as upper bounds to the expected reductions in annual cancer cases associated with the Title V standard provisions. It should be noted, however, that increased incidence of cancer is only one element of potential health effects: other nonfatal diseases and ailments may also be associated with toxic air emissions. No studies of other categories of air toxics risks appear to be available at present.

In a 1984 study, EPA estimated the risks from exposure to 45 toxic air pollutants to range from 1,300 to 1,700 annual cancer cases--out of an estimated 850,000 annual cases and 440,000 annual deaths nationwide. 12/ A more recent EPA study (February 1987) estimates annual cancer incidence from toxic air pollutants at 2,054. 13/ The maximum individual lifetime risk associated with the chemicals under study ranged from 2.4 out of 10 to 8.1 out of 100,000. For example, the maximum lifetime risk of 2.4 out of 10 for 1,3-butadiene implies that 2.4 people out of 10 near a point source (although area source emissions also contribute to measured exposures for this particular chemical) breathing a given concentration of 1,3-butadiene for 70 years, will develop cancer as a result of that exposure. Annual cancer incidence as a result of exposure to 1,3-butadiene is estimated to be 223.

It is difficult to interpret the EPA estimates in terms of benefits from the Title V requirements. On one hand, the cancer estimates are based only on a subset of all possible air toxics. Thus, they might be considered lower bounds. On the other hand, the risk assessment methods employed by EPA have been characterized as generating upper bounds estimates for individual chemical risks. Lower bounds for any given substance could be zero. Further, these estimates of benefits focus on the risk to the total population

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12. Environmental Protection Agency, *The Magnitude and Nature of the Air Toxics Problem in the United States*, draft report (September 1984).

13. Environmental Protection Agency, *Unfinished Business: A Comparative Assessment of Environmental Problems, Appendix 1*, Report of the Cancer Risk Work Group (February 1987).

and not on the maximum risks faced by any specific individual. While area sources appear to be responsible for the majority of aggregate cancer incidence, the risk to an individual at the fenceline of a major point source may be high. In the context of total annual cancer incidence--850,000--the 2,000 annual cancer cases estimated to result from exposure to air toxics is about 0.2 percent. As a policy matter, however, a high value (and therefore greater benefits) may be assigned to reducing exposures for individuals who face a greater risk than the average risk of the entire exposed population.

Section 507 of Title V mandates that hazard assessments be performed on the 402 covered chemicals (or some smaller subset). These hazard assessments may be expected to provide benefits in terms of mitigating the harmful effects of accidental releases-including human health effects and environmental and property damage. While assessing the dollar value of benefits would be very difficult, it is possible to describe these benefits qualitatively.

Conducting hazard assessments can contribute directly to human health and welfare in two ways: by helping to prevent the harmful accidental release of the covered substances, and by possibly reducing the damage associated with releases to the extent they still occur. This assumes that, as a result of conducting hazard assessments, facilities discover conditions under which releases can occur, and act to prevent them or to contain the damage that might be associated with them. Historically, the damages associated with accidental releases have been high. A 1985 EPA study documented approximately 7,000 accidental releases of toxic chemicals in the United States between 1980 and 1985 that resulted in 138 fatalities, and 4,717 injuries.[14/] Quantification of these damages would yield an estimate of the benefits associated with the hazard assessment requirements to the extent that the hazard assessment provisions induce firms to take actions to lower accidental releases, or cause the public to make more effort to avoid such risks.

Making public the hazard assessment information might provide further impetus for facility operators to institute protective measures. By imposing costly reporting requirements on facilities that handle the covered substances, the hazard assessment provisions give facility operators an incentive to find alternative production processes that avoid the use and potential release of hazardous substances.

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14. Environmental Protection Agency, *Acute Hazardous Events Database* (December 1985).

Methodologies that could be employed to estimate the benefits of Title 507 provisions include case studies of accidental releases, and responses to releases; contingent valuation studies of willingness to pay to avoid damages; and studies of the effects of regulations on damage reduction. Uncertainties as to the number and identity of the chemicals to be subject to these provisions, and the facilities to be covered, prevent a quantitative estimate of the benefits at this time.

TABLE 1. SUMMARY OF 1985 U.S. VOC EMISSIONS (In tons per year)

Source Category	Point Source Emissions	Area Source Emissions
Storage, Transportation, and Marketing of VOCs	324,613	1,000,000
Industrial Processes	1,052,166	–
Industrial Surface Coating	524,951	–
Other Solvent Use (degreasing, dry cleaning, graphic arts, adhesives, solvent extraction processes, etc.)	268,365	4,700,000
Other Miscellaneous Sources (fuel combustion, solid waste disposal, open burning, waste solvent recovery processes, and stationary internal combustion engines)	242,205	3,600,000
Mobile Sources	–	7,300,000
Total	2,412,302	16,700,000

SOURCE: Environmental Protection Agency, *National Emissions Data System.*

TABLE 2. 1985 VOC EMISSIONS BY MAJOR INDUSTRIAL POINT SOURCES (In tons per year)

Industrial Processes	Emissions [a]
Petroleum Refineries	200,470
Lube Oil Manufacture	2,507
Organic Chemical Manufacture	255,803
Inorganic Chemical Manufacture	12,836
Fermentation Processes	24,787
Vegetable Oil Processing	8,555
Pharmaceutical Manufacture	4,848
Plastic Products Manufacture	9,244
Rubber Tire Manufacture	20,185
SBR Rubber Manufacture	52,129
Polymers and Resin Manufacture	112,378
Synthetic Fiber Manufacture	27,073
Iron and Steel Manufacture	48,096
Other	273,248
Total	1,052,166

SOURCE: Environmental Protection Agency, *National Emissions Data System.*

a. May not sum to total because of rounding.

TABLE 3. EMISSIONS OF PARTICULATES AND VOCs BY STATE (In tons per year)

State	Particulates from Point Sources	VOCs from Point Sources	VOCs from Area Sources
AL	111,038	74,019	338,537
AK	3,235	14,692	45,100
AZ	44,463	3,658	237,932
AR	48,414	22,830	199,908
CA	97,087	96,495	1,964,201
CO	390,879	6,137	303,773
CT	25,100	4,001	258,056
DE	10,258	7,340	52,456
DC	882	640	34,279
FL	98,345	16,952	770,387
GA	59,351	35,447	494,975
HI	11,205	4,445	67,492
ID	18,788	1,057	255,397
IL	140,084	163,925	797,612
IN	106,827	100,361	468,985
IA	90,964	11,819	205,883
KS	89,646	32,452	187,205
KY	101,489	57,573	312,964
LA	90,816	163,714	326,455
ME	19,640	6,241	128,651
MD	20,487	13,712	321,164
MA	15,531	38,706	456,172
MI	107,920	95,329	691,189
MN	86,660	47,059	394,455
MS	28,326	32,213	214,893
MO	676,409	83,901	457,988
MT	29,452	7,595	205,765
NE	54,221	4,107	114,253

(Continued)

TABLE 3. (Continued)

State	Particulates from Point Sources	VOCs from Point Sources	VOCs from Area Sources
NV	14,496	481	86,813
NH	4,729	4,347	85,595
NJ	71,117	38,279	549,235
NM	25,909	21,418	145,397
NY	120,555	34,051	1,056,202
NC	128,059	74,091	578,011
ND	8,462	2,132	51,160
OH	168,242	94,947	865,848
OK	40,539	31,782	311,380
OR	27,747	12,714	389,171
PA	92,502	78,804	876,955
RI	954	5,990	70,437
SC	51,076	26,512	276,809
SD	28,615	1,816	73,611
TN	105,884	100,043	451,948
TX	232,088	440,120	1,420,056
UT	29,791	11,863	191,209
VT	553	1,865	56,236
VA	47,391	86,230	467,460
WA	50,451	29,198	433,130
WV	57,549	78,864	158,396
WI	34,009	49,440	409,486
WY	32,379	16,891	71,971
Puerto Rico	64,361	16,081	60,794
Guam	5,236	7,900	3,034
Virgin Islands	1,625	11	5,036

SOURCE: Environmental Protection Agency, *National Emissions Data System*.

NOTE: Data for particulates and VOC area sources are for 1984, for VOC point sources, 1985. Updated 1985 area source emissions of VOCs by state were not available at the time this report was issued.

TABLE 4. SELECTED ESTIMATES OF VOC CONTROL COSTS
(In 1986 dollars per metric ton)

Cost	Source
2,650	*Environmental Reporter*, December 1986 [a]
-490 to 8,800	Office of Technology Assessment [b]
500 to 5,000	Environmental Protection Agency [c]
27 to 9,225	Robert Crandall [d]

a. Cost in 1986 dollars of new source performance standards to control VOC emissions by the synthetic organic chemical industry, as reported in the *Environmental Reporter*, December 12, 1986, p. 1341.

b. "An Analysis of the Ozone Nonattainment Provisions of the Clean Air Standards Attainment Act of 1987, a Bill Before the Senate Committee on Environment and Public Works," Staff Paper prepared by the OTA Oceans and Environment Program, September 14, 1987.

c. Estimated range of current control costs being considered for use in cost analysis by EPA, from meeting on August 25, 1987.

d. Estimated range of control costs for hydrocarbons from Robert Crandall, *Controlling Industrial Pollution* (Washington, D.C.: The Brookings Institution, 1983), p. 36. See Table 5 for industry specific estimates.

TABLE 5. SELECTED INDUSTRY ESTIMATES OF VOC CONTROL COSTS (In 1986 dollars per metric ton)

Industry	Cost
Petrochemical	45 - 904
Structural Clay Products	1,457 - 5,535
Paint	1,333 - 1,820
Wood Furniture	7,950
Dry Cleaning	140 - 9,225
Motor Vehicles	27 - 3,960
Coil Coating	106 - 185

SOURCE: Robert Crandall, *Controlling Industrial Pollution* (Washington, D.C.: The Brookings Institution, 1983), p. 36.

TABLE 6. SELECTED INDUSTRY ESTIMATES OF PARTICULATE CONTROL COSTS (In 1986 dollars per metric ton)

Industry	Cost
Electric Utilities	52 - 3,443
Petroleum Refining	1 - 834
Chemicals	12 - 171
Iron and Steel, basic oxygen furnace	127 - 147,056
Secondary Aluminum	1,179 - 4,412
Secondary Brass and Bronze	32 - 42,078
Ferroalloys	582 - 1,682
Secondary Lead	45 -166
Asphalt and Concrete	29 - 2,606
Lime	15 - 176
Feed Mills	495 - 2,331
Grain Handling	131 - 27,250
Pulp and Paper	0 - 9,627

SOURCE: Robert Crandall, *Controlling Industrial Pollution* (Washington, D.C.: The Brookings Institution, 1983), p. 36.

TABLE 7. ESTIMATED COST OF INSTALLING BEST AVAILABLE CONTROL TECHNOLOGY TO MEET HEALTH-BASED STANDARDS (In 1986 dollars per metric ton)

Cost	Emissions
572	Maleic anhydride (benzene)
9,732	Acrylonitrile
88,215	Emissions from coke ovens

SOURCE: J. Haigh, D. Harrison, Jr., and A. Nichols, "Benefit Cost Analysis of Environmental Regulation: Case Studies of Hazardous Air Pollutants," *Harvard Environmental Law Review* (1984).

TABLE 8. ESTIMATED INDUSTRY COSTS OF CONTROLLING VOC EMISSIONS FROM MAJOR POINT SOURCES (In millions of dollars)

Industry Group	Potential Emissions Reduction (In tons/year)	Control Cost $500/ton	Control Cost $2,000/ton
Storage, Transportation, and Marketing of VOCs	194,767	97.38	389.53
Industrial Processes:			
Petroleum Refineries	120,282	60.14	240.56
Lube Oil Manufacture	1,505	.75	3.00
Organic Chemical Manufacture	85,268	42.63	170.53
Inorganic Chemical Manufacture	4,278	2.13	8.55
Fermentation Processes	14,872	7.43	29.74
Vegetable Oil Processing	5,133	2.56	10.26
Pharmaceutical Manufacture	2,909	1.45	5.81
Plastic Products Manufacture	5,547	2.77	11.09
Rubber Tire Manufacture	12,111	6.05	24.22
SBR Rubber Manufacture	31,278	15.63	62.55
Polymer and Resin Manufacture	67,427	33.71	134.85
Synthetic Fiber Manufacture	16,243	8.12	32.48
Iron and Steel Manufacture	28,858	14.42	57.71
Other	163,949	81.9	327.89
Industrial Surface Coating	314,970	157.48	629.94
Other Solvent Use	160,995	80.49	321.99
Other Miscellaneous Sources	145,323	72.66	290.64
Total	1,375,719	687.85	2,751.40

SOURCE: Congressional Budget Office. Cost estimates based on EPA emissions data.

NOTE: The estimated potential emissions reduction assumes a current control efficiency of 85 percent for the organic and inorganic chemical industry, and 75 percent for all others. New controls are predicted to achieve a total of 90 percent control efficiency in all industries.

TABLE 9. ESTIMATED COSTS OF TITLE V SECTION 502 AREA SOURCE CONTROLS (In millions of dollars)

Emissions Estimates	Area Source VOC Emissions (In millions of tons)	Emission Reductions Required by Title V [a] (In millions of tons)	Cost	
			$500/ton	$2,000/ton
Low Estimate [b]	11.3	2.7	1,350	5,400
High Estimate [c]	16.7	5.6	2,800	11,200

SOURCE: Congressional Budget Office.

a. These estimates are net of the 3.5 million tons in emission reductions ascribed to Titles I and III by the Office of Technology Assessment.

b. Estimate taken from EPA analysis of Title V costs.

c. Estimate of area source VOC emissions from all sources by EPA's *National Emissions Data System*.

TABLE 10. ESTIMATED ONE-TIME COSTS OF CONDUCTING HAZARD ASSESSMENTS, BY CHEMICAL COVERAGE AND FACILITY SIZE

Number of Chemicals Covered	Size of Facility	Number of Facilities	Cost per Facility (In dollars)	Total Cost (In millions of dollars)
20	small	21,819	4,500	98
	medium/large	7,425	21,083	157
	farms	38,523	4,500	173
				428
50	small	54,549	4,500	245
	medium/large	18,562	21,083	391
	farms	96,309	4,500	433
				1,069
150	small	163,647	4,500	736
	medium/large	56,688	21,083	1,174
	farms	290,855	4,500	1,309
				3,219
402	small	438,576	4,500	1,973
	medium/large	149,244	21,083	3,146
	farms	774,331	4,500	3,484
				8,603

SOURCE: Congressional Budget Office cost estimates.

NOTES: The number of facilities by facility size for the 402 chemicals is from "Regulatory Impact Analysis in Support of Rulemaking Under Sections 302, 303 and 304 of Title III of the Superfund Amendments and Reauthorization Act of 1986," prepared for EPA by ICF, Inc., April 1987. The same number of facilities per chemical are assumed for the other sets of chemicals covered.

The cost per facility is based on one extremely hazardous chemical located on each site of a small firm or farm, and 4 extremely hazardous substances handled by medium/large firms. The assumption of 4 chemicals for each medium/large site is taken from "Regulatory Impact Analysis in Support of Proposed Rulemaking Under Section 313 of the Superfund Amendments and Reauthorization Act of 1986," prepared by Debra Harper, Office of Toxic Substances, EPA, May 1987, pp. 42-43. Fixed and variable costs have been assumed separately for small, medium, and large facilities and farms, and are available upon request from CBO.

TABLE 11. ANNUALIZED COST OF CONDUCTING HAZARD ASSESSMENTS, BY CHEMICAL COVERAGE AND FACILITY SIZE (In millions of dollars)

Number of Chemicals Covered	Size of Facility	Number of Facilities	Annualized Cost
20	small	21,819	20
	medium/large	7,425	31
	farms	38,523	35
			86
50	small	54,549	49
	medium/large	18,562	78
	farms	96,309	87
			214
150	small	163,647	147
	medium/large	56,688	235
	farms	290,855	262
			644
402	small	438,576	395
	medium/large	149,244	629
	farms	774,331	697
			1,721

SOURCE: Congressional Budget Office cost estimates.

NOTE: To get annualized cost, the total cost of conducting hazard assessments as given in Table 10 were doubled and amortized over ten years.