REGULATORY IMPACT ANALYSIS FOR PROPOSED TECHNICAL STANDARDS FOR UNDERGROUND STORAGE TANKS

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DISCLAIMER

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Pope-Reid Associates developed the UST Simulation Model.

Meridian Research, Inc. with support from Versar, Inc., conducted the economic impact analysis of the retail petroleum industry and wrote Chapter 6 of this report. Meridian Research, Inc. also wrote Appendix E: Regulatory Flexibility Analysis.

ICF, Inc. provided the risk analysis, using outputs from the UST Simulation Model, and contributed to Chapter 7 of this report.

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EXECUTIVE SUMMARY

INTRODUCTION

Section 9003(a) of the Hazardous and Solid Waste Amendments of 1984 (HSWA) requires the Environmental Protection Agency (EPA) to "promulgate release detection, prevention, and correction regulations applicable to all owners and operators of underground storage tanks, as may be necessary to protect human health and the environment." In response to this mandate, EPA is proposing technical standards requirements for owners and operators of underground tanks (USTs) containing petroleum and other regulated substances, except substances regulated as hazardous waste under Subtitle C of the Resource Conservation and Recovery Act (RCRA). The technical standards package includes proposed regulations for new and existing tanks with provisions covering release detection, general performance standards for tank systems and leak detection equipment, mandatory upgrading of existing USTs, corrective action, closure, and reporting and recordkeeping.

Executive Order 12291 requires regulatory agencies to determine whether a proposed regulation is a major rule, and if so, to conduct a Regulatory Impact Analysis (RIA) for the proposed rule.1/ The Executive Order defines a major rule to be one that is likely to result in (1) an annual effect on the economy of $100 million or more, (2) a major increase in costs or prices for consumers, individual industries, Federal, State or local government agencies, or geographic regions, or (3) significant adverse effects on competition, employment, investment, productivity, innovation, or the ability of United States-based enterprises to compete in domestic or export markets. EPA's analysis shows that the proposed rule for the technical standards for underground storage tanks will have an annualized cost for prevention and detection greater than $100 million. This RIA provides an analysis of EPA's requirements for UST technical standards based on the guidelines contained in the Office of Management and Budget's "Interim Regulatory Impact Analysis Guidance" 2/ and EPA's "Guidelines for Performing Regulatory Impact Analyses."3/

Besides the HSWA Amendments to RCRA requiring EPA to establish technical requirements for underground storage tanks, the 1986 Superfund Amendments and Reauthorization Act (SARA) also amended Subtitle I to require EPA to promulgate financial responsibility regulations for owners and operators of underground storage tanks. The financial responsibility regulations and the technical re-requirements for USTs are being proposed separately. The financial responsibility package includes proposed regulations requiring owners and operators of USTs to maintain evidence of financial responsibility for corrective action and compensation of third parties for damages caused by releases from their USTs. The proposed regulations for technical standards and for financial responsibility are supported by separate regulatory impact analyses and other analyses (e.g., paperwork burden analyses) required by law. These analytical efforts have been coordinated to ensure consistency and accuracy, as will be subsequently discussed in this Executive Summary.

1/ Federal Register, Vol. 46, February 19, 1981, p. 13193.

2/ Office of Management and Budget, Interim Regulatory Impact Analyses Guidance, June, 1981.

3/ U.S. EPA, Guidelines for Performing Regulatory Impact Analyses, December 1983.

THE REGULATED COMMUNITY

The proposed requirements for technical standards for underground storage tanks will affect a regulated community of approximately 450,000 establishments owning an estimated 1.4 million tanks. 1/ The large majority, 96 percent, of these underground tanks are used to store gasoline and other petroleum products. The remaining 4 percent of USTs are used to store other chemicals. More than half of the petroleum product USTs are used by gas stations and other motor fuel retailers. Other industry sectors owning petroleum product underground storage tanks include: agriculture 2/, manufacturing, transportation, government and wholesale and retail trade.

An overwhelming majority, an estimated 89%, of existing petroleum USTs are constructed of bare steel. Bare steel tanks are not protected against corrosion and therefore fail more often and have a shorter average life than cathodically protected steel tanks and tanks constructed of other corrosion-resistant materials.

SCOPE OF THIS ANALYSIS

This Regulatory Impact Analysis presents the results of several analyses of EPA's technical standards for USTs containing gasoline, or petroleum products. The analyses performed for this RIA were done assuming all USTs contain gasoline. Therefore, except for a screening analysis of economic impacts for industries operating hazardous substances USTs presented in Chapter 6, the results presented here do not necessarily apply to USTs used to store any substance other than gasoline or petroleum products. However, as stated above, USTs used to store other than petroleum products account for only 4% of the UST population.

This Regulatory Impact Analysis presents, in detail, the costs, effectiveness, risks and economic impacts of alternative requirements for preventing leaks from occuring and/or detecting them more rapidly if they do occur. The analysis also considers the effect of prevention and detection measures on the costs of corrective action for plumes that may still result. This RIA analyzes the cost and economic impacts, but not the effectiveness, of the corrective action measures that are proposed by EPA -- the rationale for the corrective action policy proposed is presented in the Preamble to the proposed rule.

The impacts resulting from closure requirements are not highlighted in this RIA, but have been included in the analysis in the sense that when tanks are replaced, the replaced tanks are assumed to be closed in a manner consistent with the proposed regulation (i.e., release detection and corrective action as appropriate). The analysis of economic impacts does address the costs of closure requirements.

Recordkeeping costs are currently in the process of being developed and are not analyzed in this RIA.

1/ Data Resources, Inc., Underground Storage Tanks, Technical/Financial/ Economic Data Collection, October 2, 1985.

2/ Only underground storage tanks with capacities greater than 1,100 gallons will be regulated, thus excluding many tanks found on farms.

THE REGULATORY OPTIONS

In developing the proposed rule, EPA considered three approaches for regulating new tanks and four approaches for regulating existing tanks that were then combined in different ways to form five regulatory options. For new tanks, EPA considered the following regulatory approaches:

- o protected single-wall tanks with release detection;
- o secondary containment with interstitial monitoring; and
- o a class approach.

For existing tanks EPA considered the following regulatory approaches:

- o mandatory upgrading or replacement of substandard USTs;
- o methods of release detection;
- o frequency of release detection; and
- o phase-in of release detection.

EPA combined these general approaches for new and existing tanks into five regulatory options for prevention and detection. This RIA presents the cost and effectiveness of the five options for technical standards, in combination with the proposed option for corrective action. The analysis of the options was performed using a single corrective action policy (the proposed policy) for all the options. Only the proposed corrective action policy was assumed for each option so that the differences between the technical standards options could be compared on a consistent basis, and so that incremental differences between options could be attributed to the prevention and detection requirements and not obscured because of differences in the corrective action policy. The five technical standards options and the proposed corrective action policy are described below.

<u>Option I (Baseline level)</u>: requires manual inventory control, quarterly leak detection installed within three years (five years for corrosion-resistant tanks) for existing and new tanks, and corrosion protection for all new tanks. Periodic tightness tests may be used as an alternative to quarterly vapor wells.

<u>Option II--The Proposed Rule (Enhanced baseline plus targeted upgrading)</u>: is similar to Option I with upgrading to new tank standards within ten years, though leak detection systems must be sampled monthly rather than quarterly and tightness tests are not to be used in lieu of monthly leak detection after tanks are replaced or upgraded to new tank standards (corrosion protection).

<u>Option III (Baseline plus secondary containment for new tanks)</u>: requires quarterly leak detection or periodic tightness tests for existing tanks and secondary containment with interstitial monitoring for new tanks. For existing tanks, this option is identical to Option I. New tanks, however, must be lined systems (or double-walled tanks) with interstitial monitoring.

<u>Option IV (Class Option)</u>: requires rapid replacement of existing tanks and secondary containment for new tanks within state-designated well-head protection areas. Tanks in other areas are required to conform to baseline standards (Option I).

<u>Option V (Emphasis on leak prevention)</u>: For existing tanks, this option requires manual inventory control, frequent (continuous) leak detection starting in three years, and early retirement. Existing tanks must be replaced within ten years with secondary containment systems.

Proposed Corrective Action Policy: Where a release occurs, an investigation and actions to reduce immediate hazards are followed by limited removal of contaminated soil, and removal of any free product from the ground water. The need for subsequent cleanup at those sites where ground water is contaminated is to be determined through site-specific exposure and risk assessment.

APPROACH USED TO ANALYZE THE REGULATORY OPTIONS

Prevention, detection and corrective action are substitutes for one another in avoiding the same damages resulting from leaking USTs. As a result, it was necessary to perform an integrated analysis showing how all three requirements interact together, and to clearly present the integrated results. These aspects of the analysis and related methodological issues are discussed briefly below.

Integrated Analysis

Once preventive measures are undertaken that prevent plumes from forming, the value of additional detection measures is reduced. Similarly, detection measures that allow detection of releases before large plumes are formed can avoid much of the damages from a release, and therefore reduce the value of requiring tank systems that are less likely to fail. In addition, different combinations of tank systems and detection methods can work together to achieve similar reductions in damages, but at different costs to the tank owner.

Prevention and earlier detection can also reduce the cost of response once the leak is discovered because they result in fewer and smaller plumes that can be less expensive to clean up. Conversely, it is not necessary to rely on prevention and detection alone to avoid damages that result from leaking USTs, because response measures may also be able to achieve some of these benefits. However, corrective action will not reduce the damages that occur prior to the plume's discovery, and there can still be residual damages that remain even after corrective action is completed. Also, there can be implementation problems associated with corrective action.

Because prevention, detection and corrective action interact, it is essential to analyze them together. However, their combined analysis is difficult because of the complex dynamics that determine the occurence of tank failure, leak characteristics, effectiveness of detection methods, and variability in plume characteristics due to hydrogeologic factors. To assist the analysis, EPA developed the UST Simulation Model which simulates tank failure, leak detection, and plume development. Using the UST model, we can estimate the combined effects of prevention and detection options in terms of the number, duration and magnitude of plumes. The model also estimates the costs of prevention, detection, and corrective action, as well as other costs associated with product loss, system repairs and tank replacement.

Using the UST Model results, we can show the cost and effectiveness tradeoffs between different combinations of prevention and detection measures. We can also show how different combinations of prevention and detection measures result in lower costs for corrective action.

Methodological Issues

Improved prevention and detection measures avoid plume area, and therefore reduce corrective action costs. If corrective action requirements (and their resulting costs) were already established, then it would be straightforward to simply include corrective action costs as regulatory costs, and to present the savings in corrective action costs that prevention and detection measures provide. It would also be straightforward to include corrective action requirements and their costs in the base case -- the situation in the absence of additional federal requirements.

However, the corrective action requirements are part of the proposed rule. Therefore, the presentation of information about corrective action requires decisions about whether corrective action cost should be shown as a regulatory compliance cost, how we measure effectiveness of corrective action, and whether corrective action should be assumed to occur in the base case in the absence of other federal requirements. These decisions and their implications are discussed below.

In presenting information about corrective action, we generally show the cost of corrective action as a regulatory compliance cost that is reduced as a result of prevention and detection measures. For example, the RIA typically provides information about the cost of avoiding plumes (the cost of prevention and detection), and the cost associated with the plumes that still result (the cost of corrective action), to provide a total cost. In this way, it is easy to see the total costs resulting from the options, as well as the cost trade-offs between corrective action and prevention/detection.

Alternatively, corrective action costs avoided can be considered to be a benefit, especially if corrective action costs are viewed as a proxy for the damages incurred. Corrective action costs avoided might be considered to be a partial proxy for damages avoided if it is believed that on a site-specific basis, corrective action would be undertaken to the extent that the benefits justify the costs. Given the level of information available for effectiveness measures and benefits at this point, we generally chose not to use this alternate form of presentation in the RIA. Therefore, we generally discuss "cost savings" or "cost trade-offs" rather than "net benefits."

In this RIA we measure effectiveness in terms of plume area avoided. This intermediate measure is fairly straightforward to estimate, easy to visualize, and monotonically (though not linearly) related to most final damage measures. Ideally, we would prefer to show a more final and comprehensive measure of effectiveness that monetizes all of the benefits of avoiding plumes. Although progress has been made in this RIA in developing additional measures of benefits, plume area avoided is the most direct and reliable measure available at this point.

When comparing costs with effectiveness as measured by plume area avoided, it is important to keep the composition of the costs in mind to properly interpret the results and avoid double counting benefits. When considering only detection and prevention costs, plume area avoided can be considered to be a proxy for most of the damages associated with leaks, including those addressed by corrective action. When considering corrective action costs in addition to prevention and detection costs, the plume area avoided should be a proxy only for those damages that corrective action fails to address (primarily damages prior to detection, such as property damages and health effects).

In order to facilitate the comparison of alternative prevention and detection options, we analyzed the costs and effectiveness for all options assuming only the proposed corrective action policy would be applied for all five options. We also included the cost of the corrective action policy in the base case, implicitly assuming that corrective action would be required even if there were no additional federal requirements for prevention and detection measures. Failure to include corrective action in the base case would have obscured the trade-offs between the cost of prevention and detection, and the cost of corrective action. This RIA fully analyzes the cost and effectiveness of the prevention and detection requirements and the cost of the proposed corrective action policy, but does not analyze the effectiveness of the corrective action policy.

ANNUALIZED COST OF THE PROPOSED RULE

The Cost of the Proposed Rule

The average annualized incremental cost of the requirements for prevention and detection is estimated to be $0.21 billion (or $150 per UST). This cost includes incremental costs of installing and maintaining USTs, incremental detection and monitoring costs, incremental tank removal and replacement costs, incremental costs for pipe repairs, and adjustments for the value of product lost. The average annualized incremental costs are calculated from a base case which includes the statutorily mandated "Interim Prohibition" against bare steel tanks, and other important assumptions which are detailed in Chapter 3.

The average annualized cost of corrective action under the proposed rule is $3.05 billion. The average annualized incremental costs of corrective action under the proposed rule are less than in the base case because of the effectiveness of prevention and detection measures under the proposal. If the same corrective action requirements are assumed to apply to the base case, annualized corrective action costs for the base case are estimated to be $4.58 billion. As a result, the proposal saves $1.53 billion in corrective action costs.

In total, the $0.21 billion incremental annualized cost for prevention and detection produces an incremental annualized savings of $1.53 billion in corrective action costs, resulting in a net savings of $1.32 billion annually.

If it is assumed that the cost of the corrective action measures does not exceed the damages that are avoided or mitigated by corrective action, this result might also be viewed in terms of benefits as follows: to the extent that corrective action costs are considered to be an appropriate partial proxy for damages, then the base case is experiencing damages on the order of $4.58 billion annually, which are reduced by the proposal to $3.05 billion at a cost of $0.21 billion, yielding a net benefit of $1.32 billion annually.

Costs of the Regulatory Options

Exhibit ES.1 provides the annualized cost for prevention/detection and corrective action for the base case and each regulatory option, and also presents the annualized costs as incremental costs from the base case.

Exhibit ES.1

ANNUALIZED COSTS OF UST REGULATORY OPTIONS

	Base Case	Option I	Option II	Option III	Option IV	Option V
			($ Billion)			
(a) Total Costs						
Prevention & Detection 1/	$1.58	$1.68	$1.79	$2.19	$2.30	$2.88
Corrective Action 2/	4.58	4.13	3.05	3.86	2.56	2.07
Total Annualized Cost 3/	$6.16	$5.81	$4.84	$6.05	$4.86	$4.95
(b) Incremental Costs						
Prevention & Detection	----	$0.10	$0.21	$0.61	$0.72	$1.30
Corrective Action (Savings)	----	(0.45)	(1.53)	(0.72)	(2.02)	(2.51)
Total Incr. Cost (Savings)	----	($0.35)	($1.32)	($0.10)	($1.30)	($1.21)

1/ Cost includes tank acquisition/installation, detection/monitoring, tank removal, and an offset for reduction in product lost. Present value costs includes all capital and operating costs expected to be incurred over 30 years, discounted at 3%.

2/ Estimated costs for corrective action in each scenario, assuming EPA's corrective action requirements are applied to each scenario (including the base case).

3/ Total present value cost of prevention and detection + total present value cost of corrective action.

As can be seen from the exhibit, the incremental costs for prevention/detection and corrective action are very different across the options, but the differences in total costs are smaller. This reflects the trade-off between prevention/detection and corrective action. The total costs fall generally into two groups: the highest total costs are for the base case and Options I and III; the lowest total costs are for Options II, IV and V. Between Options II, IV and V, Option II has the lowest cost of prevention and detection, the highest cost for corrective action, and the lowest total cost.

EFFECTIVENESS OF THE PROPOSED RULE

Effectiveness can be estimated by the plume area that would be avoided if the regulation were in place (the difference between the plume area present in the base case and the plume area that will occur after the regulations take effect). The plume area avoided by each option is shown in Exhibit ES.2.

Exhibit ES.2

PLUME AREA AVOIDED RELATIVE TO BASE CASE

	Base Case	Option I	Option II	Option III	Option IV	Option V
Incremental Percent Plume Area Avoided	----	54%	67%	55%	68%	83%
Incremental Plume Acres Avoided	----	103,500	128,500	105,500	129,000	159,000

All of the options avoid a substantial percentage of the plume area in the base case -- the options avoid 54% to 83% of the plume area of the base case over thirty years. Option II, the regulatory option proposed, avoids 128,500 plume acres, or 67% of the plume area associated with the base case.

Options I and III avoid less plume area (54% and 55% respectively). Option IV avoids slightly more plume area (68%) than Option II, but will tend to avoid plumes at locations where the damages are likely to be greatest. However, concerns about implementing the class system proposed in Option IV put into question the likelihood that this performance can in fact be achieved. Option V avoids the most plume area (83%), but concerns about the feasibility of replacing existing systems with secondary containment systems and potential economic impacts put into question whether this level of performance can be achieved.

Although plume acres avoided is a useful proxy for the effectiveness of options for prevention and detection, it is only an intermediate measure of such damages as health and safety risks, property damage, damage to aquatic ecosystems, and reduction in option or existence value. Efforts to quantify these damages are complex and are still ongoing. These efforts are described in Chapter 7.

ECONOMIC IMPACTS

Economic impacts were considered for three classes of facilities which own or operate USTs: (1) facilities using USTs for storing motor fuels for retail marketing; (2) facilities using USTs for storing petroleum products for purposes other than retail marketing; and (3) facilities using USTs for storing regulated hazardous substances.

Economic impacts are far more likely to be significant for the retail motor fuel marketing class than for the other two classes mentioned above. Reasons for this include: (1) there are no substitutes for USTs in retail motor fuel marketing; (2) there are many outlets owned by small businesses; and (3) there tend to be at least three USTs per facility, so UST regulatory costs represent a potentially significant fraction of capital and operating expenses. Thus, the economic impact analysis focuses on the retail motor fuel market, though a screening analysis is performed on the other two classes of facilities mentioned above.

An economic impact analysis was conducted using a worst-case assumption that firms will not be able to recover any of the costs of the regulations through price increases. Exhibit ES.3 summarizes the potential exits of small firms in the retail motor fuel marketing sector (having annual sales less than $4.6 million) in the first five years of the regulations, assuming no revenue increase:

Exhibit ES.3

Percentage Of Outlets Owned By Small Firms Exiting Through Year 5
(Assuming No Revenue Increase)

Reason For Exit	OPTION I	OPTION II	OPTION III	OPTION IV	OPTION V
Natural Exit Rate (Current Trend)	19%	19%	19%	19%	19%
Tank Replacement or Upgrade	2%	2%	2%	15%	41%
Corrective Action	52%	50%	52%	39%	22%
Total Exit Through Year 5:	73%	71%	73%	73%	82%

Under an assumption of no revenue increase per facility and limited ability of small firms to get loans to cover compliance-related costs, the burden on small firms could be significant. These potential burdens are largely attributable to corrective action costs, although tank replacement and upgrade costs are important factors for Option IV, and the most important factor for Option V. The profitability of larger firms (excluding large oil companies) could also be significantly affected by corrective action costs, but no estimates of these exit rates are developed in this RIA.

If the assumption of no revenue increase is relaxed, the exit rates are reduced. For example, a 3% revenue increase might be a reasonable assumption for small firms since that is the level that would allow larger firms to remain sufficiently profitable. Under this assumption, for Option II, the exits due to tank replacement or upgrade do not occur, and the exits due to corrective action drop from 50% to 37%. Should a revenue increase greater than 3% occur, survival rates under Option II are projected to approach base case survival rates over the first ten years.

Because the proposed regulation may have a significant impact on a substantial number of small entities, a Regulatory Flexibility Analysis, as required by the Regulatory Flexibility Act of 1980 (5 U.S.C. 601-612), has been prepared and is included as Appendix E. The corrective action policy option chosen by EPA maximizes flexibility to determine appropriate long-term corrective actions on a site-specific basis, while at the same time adequately protecting human health and the environment. This built-in flexibility is an important factor in evaluating the potential effects of this rulemaking on small business.

IMPLEMENTATION CONCERNS

The regulatory options have been qualitatively assessed relative to one another in this RIA. The proposed regulation raises relatively fewer implementation issues relative to its alternatives (except for Option I), though implementation concerns may still be significant. Options III, IV and V rely on secondary containment which may be difficult to accomplish because of possible capacity shortages in tank manufacturing and shortages in installation expertise. The class system in Option IV may create additional implementation difficulties, while the economic impacts associated with the tank replacement requirements of Option V may hinder implementation there.

COORDINATION BETWEEN TECHNICAL STANDARDS RIA AND FINANCIAL RESPONSIBILITY RIA

The technical standards RIA and the financial responsibility RIA use similar assumptions about the size of the regulated community, the financial and operational characteristics of regulated firms, and the unit costs of complying with the regulations. However, the two analyses use different probabilities that corrective action events will occur at regulated tanks. Much of the data needed to produce precise estimates of event probabilities and costs are just not available and in the analyses for both RIAs appropriate assumptions for each analysis had to be made based upon the data and expertise available. Both RIAs present estimates of event probabilities based upon best available information.

The technical standards RIA develops probabilities and costs of corrective action for <u>all</u> regulated USTs; the financial responsibility RIA, on the other hand, develops the probabilities and costs of corrective action only for those firms that will be able to use insurance as a financial assurance mechanism. The financial responsibility RIA excludes, for example, the probabilities and costs of corrective action for incidents occurring at facilities with USTs that will not be able to obtain insurance, incidents occurring before the owner or operator has insurance, and incidents that are not reported to the insurer. The technical standards RIA may overstate the probabilites and costs of corrective action events, because the analysis for the technical standards RIA does not account for owner/operator voluntary upgrade and early retirement programs. UST owners or operators may upgrade their existing tanks to new tank standards or replace their existing bare steel tanks with corrosion protected tanks in order to reduce the risk of corrective action requirements or to increase their ability to obtain liability insurance.

In summary, the two RIAs may present different results for two reasons: (1) they examined a different population of underground storage tanks; and (2) in the analysis for both RIAs, the limited availability of data made it necessary to make assumptions appropriate for each analysis in order to produce estimates of the effects of different UST regulations. As a result of these differences, the corrective action event probabilities developed in this RIA and the insurance claim rates presented in the financial responsibility RIA cannot be directly compared.

LIMITATIONS

The results presented in this Executive Summary and in the RIA should be viewed in the context of the limitations of the analysis as presented in Chapter 9.

Chapter 1

INTRODUCTION

1.A. OVERVIEW OF THE PROBLEM OF LEAKING UNDERGROUND STORAGE TANKS

It is estimated that over one half million establishments in the United States use approximately 1.4 million underground tanks for the storage of petroleum products and chemicals.[1] About 4 percent of all tanks store chemicals, and the rest store petroleum either for retail sale (50 percent of tanks) or for the facility's own use (46 percent of tanks).[2] The tank owning facilities represent all sectors of private and public enterprise, including agriculture, mining, construction, manufacturing, transportation, communication, utilities, wholesale and retail trade, services, and military and non-military government at all levels.

Most of these underground tanks are made of bare steel, with no protective measures to prevent corrosion. Most bare steel tanks are quite old, and an estimated 60 percent have been in use for over 15 years. [3]

In recent years, mounting evidence has led to increasing concern that leakage from underground storage tanks represents a significant hazard to human health and the environment. Various investigations of the problem have identified the conditions under which underground storage tanks have a high potential for failing. While these investigations have pointed to older steel tanks without corrosion protection as being the tanks most likely to fail, other types of tanks can also fail, and tanks may fail from reasons other than corrosion. Leaking underground tanks can result in significant resource losses, both from resulting contamination of ground water and from the loss of tank contents, in health risks from contaminated drinking water, and in safety hazards from fires or explosions.

Possible responses can address tanks already in place ("existing tanks") to detect leakage and minimize its consequences, or can focus on tanks being installed in the future ("new tanks") to minimize future leaks and damages. Existing tank responses include detection measures, tank material and technological upgrades, and requirements for early tank retirement. Additional measures could require corrective action for leaks that form plumes and could impose financial responsibility requirements. New tank options can include tank technical specifications and installation protocols, as well as the other options available for existing tanks. There are many examples of public and private responses to the problem. The responses have varied, according to the needs and priorities of the parties involved.

1/ EPA, Regulation of Underground Storage Tanks, Preamble and Proposed Regulations, Draft, November 24, 1986, p. 10.

2/ EPA Office of Underground Storage Tanks, Summary of State Reports on Releases from Underground Storage Tanks, August 1986.

3/ Data Resources, Inc., Underground Storage Tanks, Technical/Financial/Economic Data Collection, October 2, 1985.

- o In states, counties, and municipalities where leaking underground tanks are perceived as a particularly important threat, statutes and regulations have been devised to require tank testing, ground-water monitoring, maintaining inventory records, and other responses to prevent or detect leaks.

- o Among gasoline retailers, the industry with the largest number of underground storage tanks, many owners--particularly the large major oil companies and their distributors--have embarked on programs of systematic replacement of the oldest tanks in their facilities irrespective of evidence of leaking, and have instituted the practice of regular tank testing or environmental monitoring.

- o Local building codes, local and national fire codes, and national petroleum trade association codes all specify recommended methods for installing and maintaining underground storage tanks.

In spite of considerable industry and public sector interest and activity in detecting and preventing underground tank leaks, information on some aspects of the problem can still be characterized as anecdotal. To address the need for systematic information on an extremely complex problem, the U.S. Environmental Protection Agency (EPA) undertook a program of studies starting early in 1984 to evaluate the nature and magnitude of the problem, identify and evaluate technical options for addressing it, and assess the need for and potential consequences of regulation.

Under the 1984 Amendments to the Resource Conservation and Recovery Act (RCRA), enacted on November 8, 1984, EPA was charged with establishing a regulatory program for underground tanks storing petroleum products and hazardous substances other than hazardous waste. Under the statutory requirement of HSWA §9003(a), EPA shall "promulgate release detection, prevention, and correction regulations . . . as may be necessary to protect human health and the environment."1/

1.B. THE PURPOSE OF A REGULATORY IMPACT ANALYSIS

Executive Order 12291 (supplemented by EPA Guidelines)2/ requires the Agency to prepare a Regulatory Impact Analysis (RIA) for every major regulation, defined as one imposing annual costs over 100 million dollars. Because of the large number of tanks, almost any regulation of underground storage tanks is major under this definition.

A principal goal of the Executive Order is to ensure that a regulation confers net benefit--that is, that the benefits of a regulation outweigh its costs to society. A second goal is that a regulation be cost-effective--that

1/ Hazardous and Solid Waste Amendments of 1984 (Public Law 98-161), Subtitle I, §9003(a), November 1984.

2/ U.S. EPA, Guidelines for Performing Regulatory Impact Analyses, December 1983.

is, to ensure that a regulation is not selected if, among the group of feasible regulatory alternatives, there is an approach that is expected to confer benefits at least as high as the proposal but at lower cost, or to confer greater benefits than the proposal but at no greater cost. The RIA supports these goals by providing a systematic presentation of information on benefits, costs, and economic impacts in a way that clarifies the implications of alternative regulatory approaches. In addition to serving as a tool for selecting from among alternatives, the RIA process can also prove useful in developing new regulatory alternatives.

The EPA has provided specific guidance regarding the contents and conduct of RIAs in the "Guidelines for Performing Regulatory Impact Analyses" and its appendices. The key elements of an RIA are:

- Stating the need for and consequences of the proposal:
  What is the problem being addressed, why is federal action necessary, and what difference is the regulatory action expected to make?

- Considering alternative approaches:
  What are the available regulatory and non-regulatory options, and what is the base case" that is likely to prevail in the absence of regulation?

- Assessing benefits:
  What are the benefits, incremental from the base case, of the proposal, including reductions in risk to human health and safety, reductions in economic property damage and resource loss, and reductions in environmental damage?

- Assessing costs:
  What are the costs, incremental from the base case, including real resource costs, government regulatory costs, deadweight welfare losses, and adjustment costs for displaced resources? What are the impacts of these costs, and who ultimately bears the costs? In addition, what are the possible adverse effects on product quality, production, competition, innovation, and market structure?

- Evaluating costs and benefits:
  What are the total and incremental benefits and costs for each alternative, and which alternative results in the greatest net benefit? If benefits cannot be easily monetized, what is the cost-effectiveness of the alternatives?

These components are interdependent. For example, stating the need for the proposal, considering alternative approaches, and assessing costs all depend critically on understanding the base case in the absence of regulation. Thus, each part of an RIA must be developed with the others in mind. Certain data input and analytical steps occur more than once in addressing the key questions posed in an RIA.

1.C THE PURPOSE OF A REGULATORY FLEXIBILITY ANALYSIS

The Regulatory Flexibility Act requires that regulatory agencies carefully consider the potential effects of regulation on small entities.[1] Small entities include small businesses (generally firms with less than 500 employees), small organizations (any not-for-profit enterprise that is independently owned and operated and not dominant in its field), or small governmental jurisdictions (any government of a district with a population less than 50,000). If the proposed regulation will "have a significant economic impact on a substantial number of small entities," the regulatory agency must prepare a Regulatory Flexibility Analysis (RFA) addressing these issues.[2] The RFA must contain:

(1) the rationale for the proposed regulatory action;

(2) the objectives of and legal basis for the proposed rule;

(3) a description and count of the small entities to which the proposed rule will apply;

(4) a description of the projected reporting, recordkeeping and other compliance requirements of the proposed rule; and

(5) an analysis of alternatives to the proposed rule.

The RFA can be incorporated into the Regulatory Impact Analysis. It is included here as Appendix E.

1.D. QUESTIONS ADDRESSED IN THIS REPORT

The basic questions addressed in the RIA apply to any regulatory activity, but are especially difficult to answer for USTs as compared to other pollution sources for a number of reasons.

- First, there are likely to be many leaking USTs, but it is not known which ones are leaking. Whether or not tanks leak, when they leak, and how they leak is largely determined by chance.

- Second, even if we knew which tanks are leaking and how they are leaking, the potential damages that result are highly variable and largely affected by site-specific factors. The same leak can be relatively unimportant in one situation, but can result in significant damages in another situation.

- Third, even if tanks are not leaking now, they might leak in the future. Evaluating regulatory options for potential future problems requires

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[1] The Regulatory Flexibility Act (Public Law 96-354) §2(a), September 19, 1980.

[2] Ibid.

the ability to make predictions about how tanks will leak, the damages that will result, and the mitigating effects of regulatory options.

o Fourth, the dynamics of failure, release, detection, transport, damages, and response are interrelated and complex. As a result, the need for regulations, and the effectiveness and costs of different options are best understood within a framework that ties these areas together in a consistent way.

o Fifth, because of the interrelationships and complexities mentioned above, requirements for new tanks, existing tanks, and corrective action cannot be analyzed in isolation. Such components of a regulatory program need to be packaged together and analyzed in an integrated manner.

o Sixth, because there are so many underground tanks owned by small businesses, almost any regulatory requirement can pose significant concerns about total costs, economic impacts, and the feasibility of implementation.

As a result, it is necessary to perform a number of analyses that must be integrated together to address the questions posed in an RIA.

The key purpose of this report is to present results to facilitate the analysis of technical requirements (i.e., requirements for prevention and detection of releases) for underground storage tanks, taking into account requirements for corrective action. Results are presented for costs, effectiveness, and economic impacts of five regulatory options which have different technical requirements, but the same corrective action component. This report also describes the methodologies and assumptions used to obtain these results and in addition addresses the sensitivity of the findings to changes in the assumptions.

1.E. SCOPE OF THIS ANALYSIS

This Regulatory Impact Analysis presents the results of several analyses which investigated the costs, effectiveness, risks and economic impacts of EPA's technical standards for USTs containing gasoline, or petroleum products. Except for a screening analysis of economic impacts for industries operating hazardous substances USTs presented in Chapter 6, the results presented here do not necessarily apply to USTs used to store any substance other than gasoline or petroleum products. However, USTs used to store substances other than petroleum products account for only 4% of the UST population.

This Regulatory Impact Analysis presents, in detail, the costs, effectiveness, risks and economic impacts of alternative requirements for preventing leaks from occuring and detecting them more rapidly when they do occur. The analysis also considers the effect of prevention and detection measures on the costs of corrective action for plumes that still result. This RIA analyzes the cost and economic impacts, but not the effectiveness, of the corrective action measures that are proposed by EPA -- the rationale for the corrective action policy chosen is presented in the Preamble to the proposed rule.

The impacts resulting from closure requirements are not highlighted in the RIA, but have been included in the analysis in the sense that when tanks are replaced, the replaced tanks are assumed to be closed in a manner consistent with the proposed regulation (i.e., release detection and corrective action as appropriate). The analysis of economic impacts also addresses these costs.

Recordkeeping costs are currently in the process of being developed and are not analyzed in this RIA.

1.F. SOURCES OF INFORMATION

The information for this report was drawn from several sources:

1. The cost-effectiveness analysis was done by Sobotka & Company, Inc. (SCI) and Pope-Reid Associates (PRA), using the UST Simulation Model.

2. The Risk analysis was conducted by ICF, Inc., using inputs from the UST Simulation Model.

3. The economic analysis of retail petroleum USTs was prepared by Meridian Research, Inc. with support from Versar, Inc. The economic screening analysis of other industries owning USTs was done by SCI.

4. The benefits analysis was conducted by Research Triangle Institute and Glen Anderson of the Office of Policy Analysis, U.S. Environmental Protection Agency.

5. Other data sources:

   o <u>Analysis of the National Data Base of Underground Storage Tank Release Incidents</u>, Versar Inc., for the Office of Solid Waste, U.S. Environmental Protection Agency.

   o <u>Underground Motor Fuel Storage Tanks: A National Survey</u>, Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency.

   o <u>Compliance Cost Calculations for EPA Regulation of Underground Storage Tanks</u>, Data Resources, Inc. for Office of Solid Waste, U.S. Environmental Protection Agency.

   o <u>Underground Storage Tanks Technical/Financial/Economic Data Collection</u>, Data Resources, Inc. and Quantum Analytics for the Office of Solid Waste, U.S. Environmental Protection Agency.

1.G. ORGANIZATION AND CHAPTER SUMMARIES

This RIA discusses the current problem regarding underground storage tanks and presents the results of several analyses of EPA's regulatory alternatives and the proposed rule. Chapters one and two introduce the problem associated with USTs and discuss the methodologies used to analyze the regulatory alternatives. Chapter three discusses the current UST universe and outlines the "no regulation" base case used in the analysis. Chapters four and five discuss the regulatory requirements, the integration of new and existing tank requirements into the five regulatory options and present the cost and effectiveness analysis of the five options. Chapter 6 presents the results of the economic impact analysis and Chapter 7 discusses the benefits of the UST regulatory options. A summary comparison of the five regulatory options is presented in Chapter 8 and the limitations of all the analyses are discussed in detail in Chapter 9.

A short summary of the contents of each chapter follows:

1. INTRODUCTION: This chapter provides an overview of the leaking underground storage tank problem by describing the current UST universe, why USTs leak, damages from UST releases, the range of possible responses to tank leaks, and the current level of response. It also describes the purpose of a regulatory impact analysis and the purpose of a regulatory flexibility analysis. Finally, it provides a summary of the information sources used for this report.

2. OVERVIEW OF METHODOLOGICAL APPROACH: This chapter presents the key issues addressed by the RIA and the approaches which are used to analyze these issues. Key issues include: (1) need for the proposal; (2) alternative regulatory approaches and their interrelationships; (3) regulatory costs and economic impacts; (4) regulatory benefits; and (5) comparison of costs and benefits. This chapter also describes the UST Model, the key tool used to evaluate the UST regulatory options.

3. DEFINING THE BASE CASE: This chapter introduces the concept of a base case and its role in the analysis. It describes the key factors that need to be estimated in order to characterize the base case. These include the distribution of USTs by use, type, age, location in relation to population and drinking water, and hydrogeological setting. For the purpose of using the UST Model to estimate costs and plumes associated with a given regulatory option, specific assumptions must be made regarding tank types, a tank age distribution, and a distribution of hydrogeological settings for USTs. Hydrogeological settings are important because they affect the performance of leak detection equipment and affect the characteristics of floating and aqueous plumes.

Current practices for leak detection and responses to tank leaks also need to be specified as part of the base case. Leak detection methods in the base case are sensory detection and manual inventory control. These are simulated in the UST Model through a base detection assumption. This chapter also provides estimates of the portion of the tank population that is currently leaking or will leak, and the implications in terms of plume area and costs.

4. COMPONENTS OF A REGULATORY STRATEGY: This chapter presents the alternatives for tank construction, leak detection, phasing, and corrective action that can be combined into regulatory options for new tanks and existing tanks. The chapter is primarily descriptive in nature, though information is presented on the advantages and disadvantages of each of the various components discussed.

5. COST-EFFECTIVENESS ANALYSIS: This chapter outlines the five integrated regulatory options analyzed in this RIA. These options are analyzed using the UST Model. Effectiveness of a regulatory option is measured as contaminant plume area that would have appeared under the base case, but is avoided under the option (i.e., plume area avoided). This effectiveness measure is considered to be a reasonable proxy for final damage measures. The major categories of costs

include: (1) initial facility costs (includes the cost of obtaining and installing new tanks); (2) detection and monitoring costs; (3) value of product lost; (4) tank removal and replacement, and pipe repairs; and (5) corrective action costs. Cost element 1 applies only to new tanks. Cost element 2 applies to all tanks. Cost elements 3, 4, and 5 apply only to leaking tanks. All costs are based on best available engineering estimates. Only cost elements affected by the proposed rules are analyzed.

Cost-effectiveness is shown two ways: (1) without corrective action costs included; and (2) with corrective action costs included as part of the regulatory costs. Furthermore, regulatory costs with corrective action are presented relative to a base case without any corrective action, as well as relative to a base case with corrective action.

6. ECONOMIC IMPACTS: Economic impacts are analyzed for three UST-using sectors: (1) facilities using USTs for storing motor fuels for the retail market; (2) facilities using USTs for storing fuels for non-retail purposes; and (3) facilities using USTs for storing hazardous substances. The analysis concentrated on the retail motor fuel sector because that is where economic effects are likely to be most significant. Economic impacts were assessed using a return on assets approach.

Under assumptions of no revenue increase per facility, limited ability of small firms to get loans to cover compliance related costs, limited ability of firms to get insurance for releases, and no corrective action in the base case, the burden on small firms could be significant, with most of the exit being attributable to corrective action costs. A sensitivity analysis is used to explore the effect of relaxing some of these assumptions. For example, under a 3% revenue increase, large firms are not adversely affected, though some small firms are still projected to exit within the first five years because of the corrective action requirement. A Regulatory Flexibility Analysis is included as Appendix E.

7. BENEFITS ANALYSIS: Forty-four case studies of UST release incident damages were used to identify the types of damages caused by leaking USTs and place monetary values on some of the major types of damage. Damages were monetized by estimating the actual sums spent to repair damages caused by releases (e.g., replacing contaminated wells, compensation for damaged structures) plus the losses to businesses closed or disrupted by the releases and the contamination they caused.

Given a distribution of monetary damages associated with serious release incidents, total damages are calculated using estimates of the number and size of leaks under the base case, the proposed rule, and various regulatory options. These estimates are made using the UST Model. Data from the Release Incident Survey provide estimates of frequency with which releases of various sizes are likely to have serious consequences (e.g., lost drinking water resources , or vapor contamination). UST Model predictions of the timing of the damage incidents are used to discount the monetary damages back to the implementation time of the regulations, providing estimates of the present value of the damages.

The risks avoided by the proposed rule were not considered in the same framework discussed above, due to the problem of monetizing health risks. Instead, the UST Model's outputs, in terms of predicted frequencies and magnitudes of contamination incidents, were used as inputs into a separate analysis which examines concentrations of carcinogens at various possible exposure points, the size of the exposed populations, and the duration of exposures.

8. IMPLEMENTATION CONCERNS AND COMPARISON OF REGULATORY OPTIONS: This chapter presents a summary comparison of EPA's five UST regulatory options. This comparison draws on the information on costs, effectiveness, economic impacts and benefits presented in previous chapters. Five exhibits present summary data from previous chapters.

9. LIMITATIONS OF THE ANALYSIS: This chapter lays out the uncertainties inherent in the analyses. With respect to the UST Model, these include uncertainties due to data inputs, as well as uncertainties in the modeling process. There are also uncertainties in the base case specification, assumed unit costs, population of affected USTs, economic status of affected parties, and benefits assessment. These uncertainties combine to imply that a regulatory option revealed to have a modest advantage in the analysis may not necessarily the best. However, comparative results between two options generally carry more confidence than absolute estimates associated with any given option.

APPENDICES:

Appendix A: Summary of the UST Model
Appendix B: Zip Code Analysis of UST Location and Population Density
Appendix C: UST Model Specifications
Appendix D: Economic Impacts Assessment Methodology
Appendix E: Regulatory Flexibility Analysis
Appendix F: Methodology for Estimating Risk

Chapter 2

OVERVIEW OF METHODOLOGICAL APPROACH

This chapter provides an overview of the types of information and analyses that are encompassed in this RIA. It presents the basic questions to be addressed in the RIA and sets the context for how these questions will be answered with respect to the UST issue. It then presents a brief description of the UST Model, the key tool used to assess the cost and effectiveness of UST regulatory alternatives.

2.A. COMPONENTS OF AN RIA

The basic questions addressed by an RIA are:

1. What is the need?
2. What is the proposal and what are its consequences?
3. What are the alternative approaches?
4. What are the costs?
5. What are the benefits?
6. How do the costs and benefits compare for the alternatives?

All of these questions are interrelated and depend on much of the same underlying data and analyses. For example, establishing the need for federal intervention and evaluating the benefits of alternatives is largely dependent on the same type of information and analysis. The overall purpose of an RIA is to pull together the various data and analyses in a consistent and comprehensive way, with the goal of highlighting the trade-offs for the alternatives under consideration.

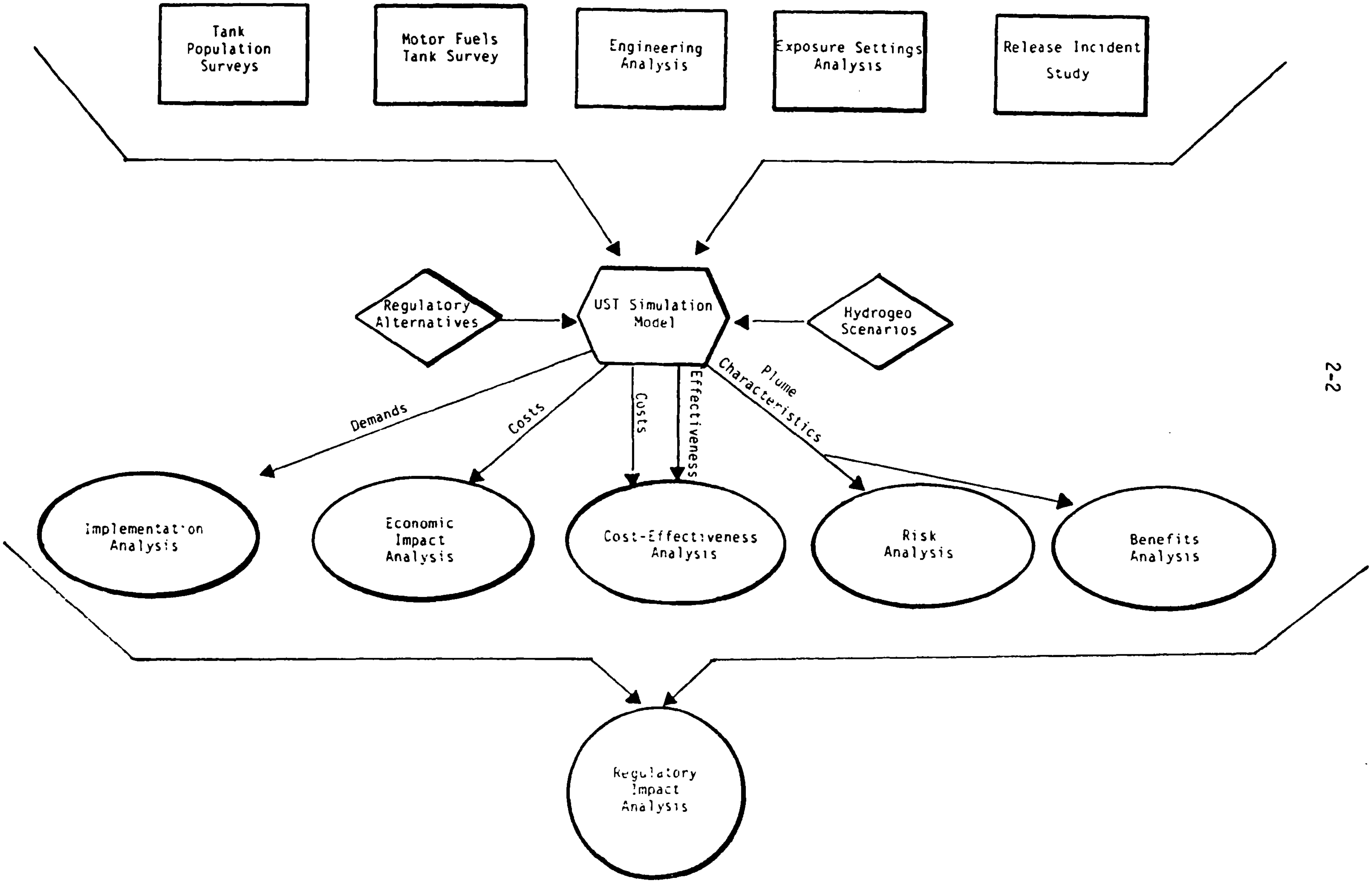
The following discussion provides an overview of the types of information and analyses that are encompassed by this RIA. The discussion is organized according to the basic questions addressed by an RIA. Generally, we begin by discussing the types of information needed, and then identifying how different types of analyses contribute toward providing the needed information. Descriptions of how these analyses are performed are discussed elsewhere in this report. Exhibit 2.1 provides an overview of the analyses referred to in the discussion that follows.

2.A.1. Need for the Proposal

The beginning of an RIA is devoted toward establishing the need for federal intervention. This need is generally established by developing an assessment of the damages that would occur in the absence of federal intervention.

This needs assessment is often referred to as the "base case," because it also provides a reference point for determining the consequences of the alter-

Exhi 2.1
INFORMATION AND ANALYSIS FOR UST RIA



natives being considered. Ideally, the base case includes consideration of the effects of state and local requirements, and of changes in industry practice that would prevail in the absence of federal requirements. In practice, this is difficult to determine. Once the need is established, the bulk of the remainder of the RIA is oriented toward evaluating the consequences of alternatives for federal intervention relative to the base case.

2.A.1.a. Types of Damages from UST Releases

The need for regulatory intervention is best described in terms of the types of damages that might occur as a result of leaking underground storage tanks. The discussion here is divided into damages that can occur prior to detecting leaks, and those damages that may occur after the leak is detected. This division is useful because it corresponds to different types of regulatory responses that become effective either before detection (technical standards and financial responsibility) or after detection (corrective action).

Before Detection

Some of the types of damages that result from leaks, such as the cost of lost product, are borne directly by the owners of the tanks. In addition, leaks may cause foundation water-proofing to break down, foul sump and drainage systems, or damage electrical conduits, buried cables, piping or pumps. Leaked product may seep into basements or foundations, creating unpleasant or toxic vapors. These vapors may pose a health risk to workers and a potential fire or explosion hazard. Product residues in soil may volatilize and pose a potential health risk to workers and customers.

Damages may also occur beyond the facility, as the released product travels on or through the ground water, or by other routes such as sewer lines. Some of the potential damages are similar to those occuring on-site, such as materials damages, the risks of fire and explosion, and health effects associated with the volatilization of product. Additional types of damages include potential health risks to those who drink ground water or surface water that has been contaminated. The magnitude of these effects will naturally depend on the proximity of the facility to houses, businesses, and underground utility cables, and whether the contaminated water is used for drinking or other purposes.

In addition to these off-site effects, the leaked product may contaminate soil, causing loss of crops and soil productivity, and may also affect plant and animal life. Ground water that is used for irrigation or industrial purposes may also be affected; users of such water may find yields decreasing or adverse effects on the quality of the products they produce. There may also be some nuisance effects involving taste, odor or visual sensess (such as oil slicks) as the release becomes detectable.

A final variety of off-site effect that may occur is referred to as option value damage. Option value is a value placed on a resource because of its potential to be used in some (possibly unforeseen) way in the future. Even though a resource (such as ground water downgradient from the UST) is not currently being used, there may still be economic value to protecting it in an uncontaminated condition because of the possibility that it will be used in the future.

After Detection

After detection, all of these types of damages may continue to occur. In addition, anxiety may be another effect of the leak. Nearby residents may fear the contamination of their water supply or fear an explosion; even if the tangible harm does not occur, there has been some damage to these individuals' welfare. As a result, nearby property values may fall. 1/

Once the leak has been detected and stopped, there is a choice of doing nothing and knowingly accepting further damages, or taking steps to mitigate future damages. Of course, such mitigating steps have costs associated with them. Presumably, the only mitigating measures that should be undertaken are those that confer benefits (avoided future damages) in excess of the costs of the mitigating measures. In these cases, the cost of the mitigating measures becomes a measure of damages; care should be taken not to count both the avoided damages and the cost of avoiding them, as this would be double-counting. The mitigating measures can be undertaken singly or in various combinations, and include: degrees of corrective action (removing the contaminated soil at the tank, removing the floating plume, and removing the dispersed plume), treating contaminated water prior to use, and using alternative water sources.

Damages are Variable

The incidence and severity of problems in the base case range widely. Generally, whether or not a tank is now leaking, whether it will leak in the future, and the leak characteristics depend on several factors including the characteristics of the tank, the soil setting, and chance. Moreover, the damages that result from these leaks are highly dependent on site-specific factors. Even for two leaks with exactly the same leak rate and duration, the resulting damages can vary greatly and depend on a number of factors including: the hydrogeologic setting, other avenues of transport, the proximity of people, structures and surface water, and the current and future uses of the contaminated water.

2.A.1.b. Type of Analysis

To determine the damages resulting from the base case, we need information and analysis in several areas. First, we need to evaluate the existing and future tank population to estimate which tanks will fail, when they will fail, and how they will fail. Second, we need to estimate the types of damages that will result due to these expected failures. Third, this evaluation must incorporate consideration of the measures that are already being taken or are expected to be taken as a result of prior requirements (such as the statutory interim prohibition for new tanks) or by requirements of state and local authorities, and by industry. The alternatives considered for federal action should not be burdened by the costs that are borne as a result of measures already taken,

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1/ A change in the market value of nearby properties as a result of potential ground water contamination from leaking USTs is a pecuniary effect, and not an additional damage itself; instead, it is a market reflection of the perceived damages that may occur.

nor have attributed to them the benefits that have already been captured by these measures.

We evaluated the likelihood that the existing tank population is leaking, the characteristics of the leaks, and the resulting damages in several ways. First, we looked at past experience using the State Release Incident Survey. Approaches that relied on reported information help characterize leaks that are known and the resulting damages, but do not necessarily represent ongoing leaks that have not been detected or reported, or that have not yet occurred. Second, we looked at current experience by examining the National Motor Fuel Tank Survey. Survey approaches attempt to identify undetected leaks and help us assess the extent to which tanks are now leaking without our knowledge, and the severity of these leaks. Third, we examined case studies in depth to help provide perspective on a variety of aspects of the problem, including the damages that result and ways in which to evaluate damages. Fourth, we simulated current and future tank system failures through modeling methods such as the UST Model (discussed later in this Chapter) that incorporate our best understanding of the factors that lead to leaks, determine leak characteristics, and determine the damages that result. The UST Model simulates potential damages in terms of plume size and duration, and these results may be interpreted to determine the total resulting damages. Such a simulation could characterize undetected and future leaks, which are hard to predict using only data about known leaks. The UST Model is especially useful for identifying the effect of regulatory alternatives because it predicts plume size and duration under the base case as well as under the regulatory alternatives.

2.A.2. What Are the Alternative Approaches?

2.A.2.a. Types of Approaches

Technical Standards

Damages can be avoided by preventing leaks in the first place, or damages can be reduced by detecting leaks earlier. To a large extent, these choices can be thought of in terms of requirements for new tanks versus requirements for existing tanks.

Different types of tank systems fail very differently. Corrosion is a principal cause of leaks in bare steel tanks. If tanks are corrosion resistant, they are much less likely to leak. If tanks also have some form of secondary containment, they are even less likely to have releases into the environment. To the extent that new tank requirements result in fewer failures, more leaks will be prevented in the future. Since much of the existing bare steel tank population is nearing retirement, new tank standards may have a significant effect on the potential problems remaining from USTs in a decade or so.

Early replacement of tanks might also prevent leaks from occuring, or might result in detecting leaks that are under way. In determining the desirability of early replacement, it is important to assess the likelihood that older tanks are more likely to leak.

Early detection can reduce the damages that result from leaking tanks, whether they are leaks from existing tanks, or leaks from new tanks that meet new tank standards. There are a wide range of continuous and periodic detection options that can reduce damages by detecting leaks sooner. All of these methods have different levels of sensitivity and reliability. The contribution of any detection method is more significant for tanks that are likely to leak than for tanks that tend not to leak as much. The relative performance of the detection method may depend strongly on the characteristics of the leaks which, in turn, can also depend on the type of tank. Some detection methods depend directly on the leak rate, others are affected by the accumulated leak volume, while other detection methods may not detect leaks well that occur in particular locations in the tank system. In addition, some methods perform independently of the environmental setting, while the performance of other methods depends on the characteristics of the unsaturated or unsaturated zone.

Interrelationship of Prevention and Detection

Generally, prevention and earlier detection are substitutes for one another in avoiding the same damages. Therefore, it is important to avoid double counting when assessing the benefits associated with prevention and detection. Once preventive measures are undertaken, the value of additional detection measures is reduced. Similarly, very effective detection measures can avoid much of the damages, reducing the value of requiring the use of tank systems that are less likely to fail. In addition, different combinations of tank systems and detection methods can achieve similar reductions in damages, but possibly at much different costs to the tank owner.

Identifying and evaluating the trad-eoffs regarding effectiveness and cost for different combinations of prevention and detection can be difficult given the inherent complex interrelationships and variability that exist between tank failure, hydrogeologic setting, and exposure setting.

Interrelationship of Technical Standards and Corrective Action

Technical standards and corrective action can be substitutes for one another in avoiding some of the same damages. Technical standards--prevention and earlier detection--can reduce the cost of response once the leak is discovered, because technical standards would result in fewer, and smaller plumes that can be less expensive to clean up; smaller plumes could also reduce the need for treating water supplies or obtaining alternative water sources. Conversely, it is not necessary to rely on the technical standards alone to avoid damages that result from leaking USTs, because response measures may be able to achieve some of these benefits also. Ideally, alternatives for prevention, detection and for corrective action should be developed and considered together in order to avoid double counting benefits, and to make the most cost-effective use of all three together.

2.A.2.b. Types of Analysis

Analyzing the regulatory alternatives is far more difficult than developing and understanding the base case because it is necessary to project how the alternatives will alter costs and benefits from the base case. This is especially complex for technical standards for USTs because of the role of chance in determining tank failure and leak characteristics, the complex dynamics that determine the effectiveness of alternative detection methods, the variability in plume characteristics due to hydrogeologic factors, and the variability of the damages that result due to variability in such factors as the proximity of people and the uses of the contaminated ground water.

To assist in our analysis, we have developed the UST Simulation Model which estimates the effects of regulatory alternatives using current information and consistent assumptions. The outputs of the UST model are then used as inputs into cost and effectiveness analyses, an economic impact analysis, and the benefits analysis. These results are then systematically presented in this RIA in combination with all other relevant studies to clearly present the trade-offs associated with the alternatives. Because of the central role of the UST Model in integrating analyses and providing key inputs into follow-on analyses, the UST Model is briefly described later in this chapter. More complete descriptions are provided in Appendix A and in the UST Model Documentation. 1/

We currently use the UST Model to analyze the effects of the regulatory options on gasoline-containing USTs. Hazardous substance-containing USTs are not currently modeled because they represent only 4% of the UST universe. Modeling USTs that contain hazardous substances is a more complex endeavor and requires far greater data collection efforts because these USTs could theoretically contain any of hundreds of hazardous substances, each requiring its own set of modeling parameters. In essence, the 4% of hazardous substance-containing USTs are modeled as gasoline USTs for purposes of estimating the total cost and effectiveness for a given option.

2.A.3. What Are the Costs?

There are several different classes of costs to consider in an RIA. These can be divided into direct costs, economic impacts, and implementation costs.

2.A.3.a. Direct Costs

The direct costs of regulatory alternatives are those costs which can be attributed to the alternatives. These costs include the costs associated with installation and operation of detection methods, the costs associated with meeting new tank requirements, and the costs associated with related items such as closing a facility for tank testing (which may result in forgone profits).

1/ Pope-Reid Associates, Inc., Final Report: Underground Storage Tank Model, December 1986.

For requirements leading to early retirement, direct costs include the costs associated with forgoing the use of the existing tank. To assess this, it is necessary to estimate how long the tank would have been in service, which in turn may depend on when the tank is expected to fail.

The cost estimates should include both the total costs and the incremental costs above the base case costs, that would have been incurred in the absence of the regulatory alternative. However, it is not always clear whether a certain activity should be included in the base case or be attributed to the proposed regulation. For example, current state requirements or industry practice might suggest that a certain activity would take place even in the absence of regulatory change. Yet the state requirements or industry practice may have been developed in anticipation of federal requirements. When it is not clear whether a certain activity should be included in the base case or attributed to the regulation, it will be attributed to the regulation so as not to understate regulatory costs.

In addition, the regulatory alternatives may result in some savings over the base case. For example, more expensive tank systems that fail less frequently might result in less costs for repair and replacement than would occur in the base case. Other savings include reduced product loss or reductions in costs of responding to leaks. Care must be taken to avoid double counting savings, by ensuring that either credit is given as cost savings or as damage reductions, but not both.

Actual data and estimates from best engineering judgement were used to establish unit costs for alternative detection and tank requirements. These were applied to the estimated tank population to develop estimates of total and incremental costs for the tank population as a whole.

Similarly, the UST Model incorporates these estimates as inputs for estimating direct costs for the groups of tanks being analyzed. The UST Model also estimates the expected remaining useful lives of existing tanks of different types and ages, and can be used to estimate the costs associated with early retirement of existing tanks. Since the UST Model also tracks the cost of product loss, repairs and replacement, it can be used to estimate the incremental savings over the base case for regulatory alternatives.

2.A.3.b. Economic Impacts

The economic impacts of the direct costs depend on their magnitude and on who bears them: they may be passed forward to consumers in the form of price increases, absorbed by the owners or operators, or passed backward to production factors. To the extent that closures occur when costs are absorbed by owners, unemployment may result. Other types of economic impacts include impacts on competition, product quality, productivity, and innovation. Concerns about economic impacts may be high because there are a large number of tank establishments, many of whom are small businesses, that may be sensitive to even relatively small incremental costs due to the regulatory alternatives.

The economic impact analysis, presented in Chapter 6, uses cost inputs from engineering analysis and the UST Model as a basis for evaluating potential impacts of technical requirements. The key economic impact of concern is the potential effect on the viability of affected entities. A return on assets approach is used to predict the effect of regulatory alternatives on viability. Return on assets was chosen because the rate of expected return on assets is reasonably consistent across industries and size classes and there are documented benchmarks which correspond to likely failure and severe financial distress. The economic impact analysis concentrates on the retail motor fuel sector because this is where economic impacts are likely to be most significant. This is the case because in this sector there are no substitutes for USTs and there are many small businesses. For other USTs (i.e., non-retail fuel and hazardous substances), a less detailed screening analysis is presented.

Because of the concern for the potential effect on small businesses, a Regulatory Flexibility Analysis, as required by the Regulatory Flexibility Act of 1980, has been conducted and is included as Appendix E to this report.

2.A.3.c. Implementation Costs

The cost and feasibility of implementation, both to regulators and to the regulated community, can significantly affect the relative desirability of the alternatives under consideration. There are numerous regulatory choices that can significantly affect the cost and feasibility of implementation for the overall UST program.

For example, the timing and scope of detection requirements can significantly affect the timing and magnitude of demands on firms providing corrective action and closure services, as well as affect the government entities overseeing corrective action and closure. If, for example, a large percent of existing tanks are leaking, an immediate requirement for testing would result in significant immediate demands for corrective action. Prevention-related requirements have the opposite effect. These requirements can significantly reduce demands on the corrective action program in the long run by reducing the number and size of releases. Detection-related requirements could also reduce demands on the corrective action program and the private-sector resources it employes, but would result in more strain on detection equipment manufacturing and operating capacity, and relatively larger government resource requirements for ensuring compliance.

Various analyses can help shed light on the cost and feasibility of implementation. The demands on various aspects of implementation can be assessed from the same types of analyses used to analyze costs and benefits. Additional studies, such as an analysis of industry capacity for supplying tanks and detection services, and an assessment of the capabilities of state programs, provide additional perspective on feasibility. It is therefore important to evaluate implementation trade-offs along with all of the other trade-offs associated with the different alternatives under consideration. At a minimum, it is helpful to evaluate regulatory alternatives relative to each other from an implementation perspective. That is, rather than trying to estimate the absolute magnitude of implementation costs for each regulatory alternative being considered, it is often sufficient to rank remaining alternatives. Such an analysis is presented in Chapter 8.

2.A.4. What Are the Benefits?

2.A.4.a. Types of Benefits

The benefits of the alternatives are the damages avoided which were mentioned earlier in the discussion of the need for the proposal.

2.A.4.b. Types of Analysis

The UST Model provides a systematic basis for evaluating how different regulatory options would be expected to reduce the damages that motivate regulation. The UST Model provides information about the performance of different combinations of tank types and detection methods in different hydrogeological settings. The cost outputs include the costs associated with product loss, tank repair and replacement, and corrective action. Measures of damages include plume areas and plume durations that result for the leaks that occur during the period that the leaks remain undetected. These estimates can be used as starting points for additional analyses that estimate the health risks and other damages that may result. Chapter 7 addresses such valuation issues.

2.A.5. How Do the Costs and Benefits Compare?

2.A.5.a. Types of Information

As previously shown in Exhibit 2.1, a number of studies provide key information to help characterize the base case. These studies, in conjunction with engineering analyses, provide inputs into the UST Model. The UST Model provides a consistent and systematic basis for analyzing the effects of the regulatory alternatives in terms of changes in different types of costs, and changes in plume characteristics. The outputs of the Model are then used in the economic analysis and benefits analysis. All of these results then must be compared in ways that facilitate making a decision to select one of the regulatory alternatives, or to develop a new one.

2.A.5.b. Types of Analysis

The cost-effectiveness analysis provides a framework for comparing the trade-offs associated with the regulatory alternatives. Comparisons are straight forward when the information is quantitative--for example:

- o How different alternatives compare in terms of cost per acre of plume avoided, or cost per case of statistically expected cancer avoided.
- o Whether costs can be substantially reduced, without greatly reducing benefits, by tailoring requirements to be less stringent where damages are not expected to be high anyway; or conversely, whether benefits may greatly increase, with limited increases in cost, by tailoring requirements to be more stringent where the damages are expected to be high.

However, there are many factors that are difficult to incorporate into this simple cost-effectiveness framework because we cannot place dollar values on them. These include damages that we know about but cannot fully quantify and business failures expected to result from the proposed rule. In addition, other practical concerns, such as implementation, can significantly affect regulatory choices. Finally, the overall evaluation of whether the benefits of the proposal exceed its costs cannot be reduced to a quantitative expression, but rather is a judgemental balancing decision informed by the RIA and other sources of information.

2.B. OVERVIEW OF THE UST MODEL

This section provides an overview of the UST Model. A more detailed description of the inputs and outputs of the model and how the model works is included in Appendix A, or can be found in Pope-Reid Associate's final report of the UST Model documentation. 1/

2.B.1. Summary Description of EPA's UST Model

EPA's UST Model is based on a detailed specification of all of the ways in which different types of tank systems can fail in different environmental settings, the likelihood that these failures will occur over time, and the characteristics of the leaks that result from particular failures. Based on these specifications, we can simulate the problems that occur month-by-month, allowing chance to operate during the life of a particular type of tank in a particular setting. The tank may not leak, or it may leak more than once. For the leaks that occur, the model simulates the movement of the product through the unsaturated zone and the development of the plume until the leak is discovered. The timing of the discovery of the leak can depend on the point of detection, and the sensitivity, frequency and reliability of the detection measures that are assumed to be used. We can also repair tank systems or replace them when the leaks are discovered, undertake corrective action that is based on the size of the plumes that result from the leaks, and keep track of all of the costs that are incurred. Exhibit 2.2 provides a simple flow diagram that illustrates the sequence of steps undertaken in the model.

By repeating the simulation of individual tanks many times, we can develop an understanding of what happens to a population of identical tanks in the same situation. We can do this analysis in environmental settings that have different soil characteristics, different depths to ground water, and different groundwater velocities to see how these parameters affect failure and leak characteristics. We can see how the same spectrum of leaks results in different plume characteristics in different hydrogeological settings. We can also see how this all compares for different types of tank systems in combination with different detection options. We can scale the results to represent the actual tank population, based on our understanding of the distribution of tanks across hydrogeological and exposure settings.

The outputs of the model can then be used as inputs into an exposure analysis that translates plumes and their durations into risks, an economic

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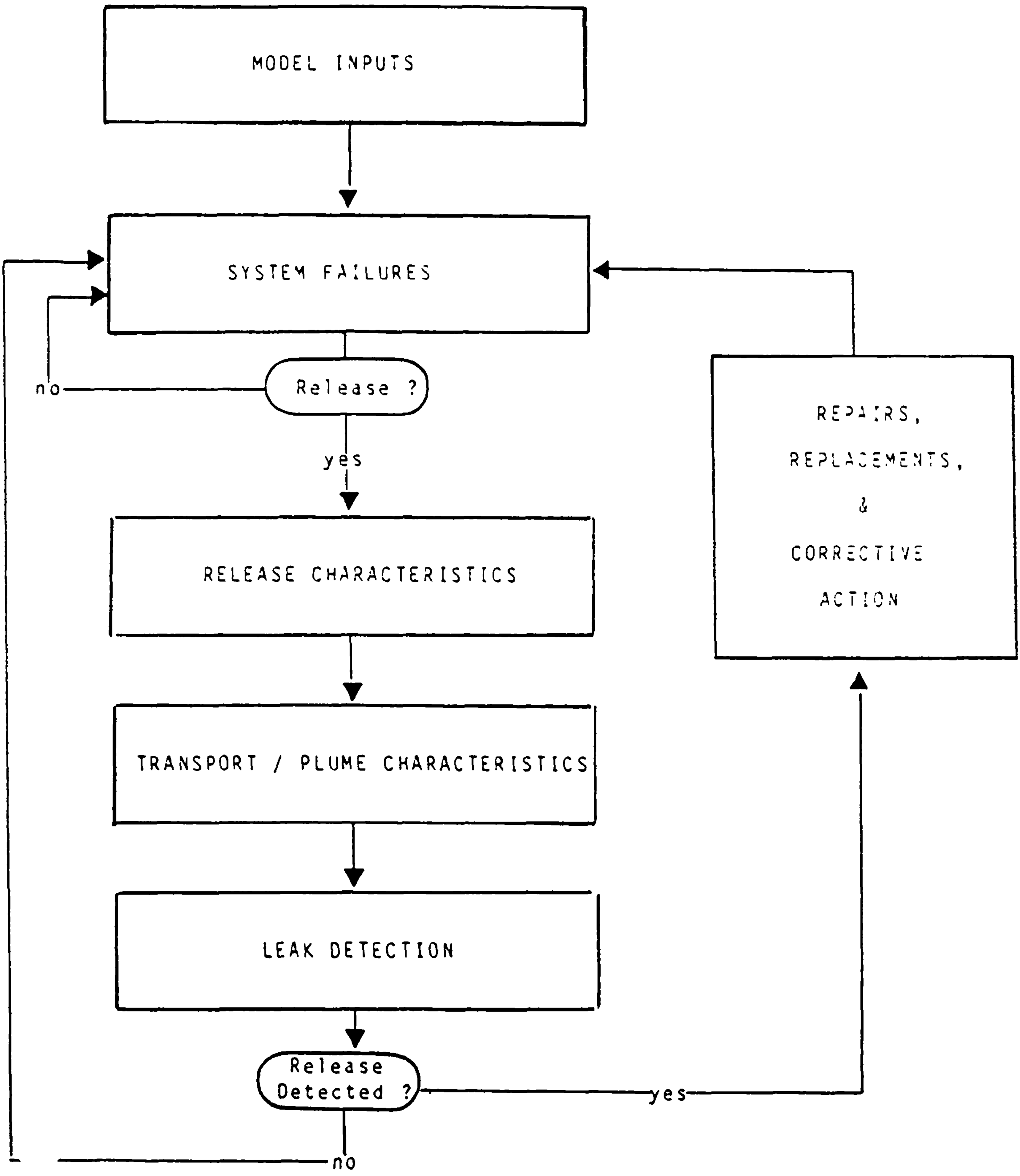
1/ Pope-Reid Associates, Inc., Final Report: Underground Storage Tank Model, December 1986.

Exhibit 2.2
SIMPLE FLOWCHART OF UST SIMULATION MODEL



analysis that translates costs and cost savings into economic impacts, and an implementation analysis that translates information about the performance of regulatory options into demands on different aspects of implementation.

2.B.2. Limitations

This type of approach requires a great deal of information. To a large extent, information about underground storage tanks is not available. Some data, such as the number and type of tanks being used, has been collected in the past year or two. EPA's Release Incident Study 1/ and Motor Fuel Tanks Survey 2/ have provided some information on the types of releases, the extent of damages and the percentage of tanks that may be leaking. Other information needed for this analysis, such as data regarding tank performance and the performance of leak detection equipment, is not yet available. Many tank types and most leak monitoring equipment are relatively new, and therefore the performance of these tanks and equipment has not yet been documented. Because much of the information needed to do this analysis is limited or unavailable, assumptions based upon the limited data available and best engineering judgement must be used in place of data. To the extent that there is uncertainty in the assumptions, there is uncertainty in the analysis and in the results of the analysis. However, any comprehensive analysis that attempts to accomplish the same results will face this same limitation.

At present, we use the UST Model to simulate USTs containing motor fuel. Tanks storing motor fuels represent 96% of the UST universe. The remaining 4% of the UST universe consists of USTs containing hazardous substances. These hazardous substances can be any substance designated as hazardous under CERCLA §101(14), other than hazardous wastes. In order to accurately model this 4% of the UST universe, it will be necessary to make assumptions about the distribution of hazardous susbstances over USTs, the fate and transport of hazardous substances, the age distributions and hydrogeological settings for hazardous substance-containing USTs, the level of base detection, and other parameters. Sufficient data is not yet available to take on this extremely complex task. Therefore, the analysis is currently conducted by assuming all 1.4 million USTs in the UST universe contain motor fuel.

One advantage of the UST model is that it requires that assumptions and data be used in an explicit and consistent manner. If there is uncertainty about particular assumptions used in the analysis, the model can be used to conduct sensitivity analyses to make the importance of that uncertainty clear. In addition, given the complex interrelationships that are inherent in the UST situation, the model results can identify the significance of the assumptions that otherwise might seem less important when considered in isolation. Finally, the model can easily be revised or calibrated to reflect data as it becomes available. As such, the UST Model is a means to fully exploit available data, other models, and judgement in a systematic, comprehensive and controlled way.

1/ EPA Office of Underground Storage Tanks, Summary of State Reports on Releases from Underground Storage Tanks, August 1986.

2/ Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency, Underground Motor Fuel Storage Tanks: A National Survey, May 1, 1986.

2.B.3. Model Outputs

The model provides specific sets of outputs for a given type of tank and detection method in a given hydrogeological setting. Each time the model is used, we can tailor or change the assumptions regarding the tank type, detection method and the hydrogeological setting to reflect information known about the UST universe. The outputs that result from each of the tailored model runs become key inputs to other analyses such as cost and effectiveness, benefits, economic impacts and financial assurance. These outputs include measures of effectiveness such as the frequency of release incidents, release rates, the distribution of release volumes for a given number of tanks over a given period of time, and the time it takes to detect a release given specific hydrogeologic settings, specific leak monitoring equipment and the distribution of plume areas. The model also provides total discounted costs and yearly costs for equipment installation and operation, equipment repairs and replacements, product lost, and corrective action. Further explanation of the model outputs as well as examples of how these outputs are incorporated into different analyses are provided in the remaining chapters of this report.

Chapter 3

DESCRIPTION OF THE PROBLEM: DEFINING THE BASE CASE

3.A. INTRODUCTION: THE CONCEPT OF A BASE CASE AND ITS ROLE IN THE ANALYSIS

When evaluating the benefits and costs of potential technical standards, it is necessary to compare them to the benefits and costs that would have prevailed in the absence of the new requirements. This "base case" describes the current universe and practices in the absence of any regulation, and establishes a reference point for the technical standards. The selection of the base case can have a significant effect on the performance of options relative to an alternative of no regulation; however, the base case does not affect the performance of options relative to one another.

Often, it is not clear what the base case should be. For example, the base case for new tank requirements may be corrosion protected tanks with minimal operational requirements (base inventory control) since this is the current requirement under the interim prohibition. On the other hand, if state regulations require leak detection for new tanks, then it may be more appropriate to establish a different base case for evaluating the incremental costs and benefits of federal requirements. Once the base case is established for a given set of regulatory requirements, it can be used throughout the analysis as a representation of the regulated universe in the absence of any regulation and as a reference point for comparing the results and impacts of the regulatory alternatives.

The first sections of this chapter identify those elements of the current petroleum tank universe that are key to the establishment of the base case and describe the current knowledge of these factors. The last part of the chapter describes how the base case was modeled using EPA's UST Simulation Model and how the base case can be used in evaluating the regulatory alternatives.

3.B. OVERVIEW OF KEY FACTORS

The country has a large number of underground storage tanks, many of which are old and are not protected against corrosion. They are found near where people live and work, and to a somewhat lesser extent, they are found near drinking water sources. If an UST is leaking, the released product can move through a chain of pathways to affect water sources, air, and structures adversely and the resulting damages to health, property, and the environment can be costly or impossible to avert or repair. Thus, USTs could potentially pose serious problems, which could be addressed with a regulatory program.

The following sections provide background information on the key factors involved in establishing the base case for the underground storage tank regulatory analysis. Section 3.G. outlines the established base case and characterizes the base case in terms of the key factors.

3.B.1. Why Does a Tank Leak?

A large proportion of the current population of underground storage tanks are constructed of bare, unprotected steel. The average age of bare steel tanks is between 15 and 20 years.[1/] When steel is exposed to the natural environment and the elements, it corrodes. If a steel tank is left unprotected and exposed to natural conditions for many years, corrosion takes its toll, holes form in the walls of the tank and the tank may leak.

3.B.2. What Happens When a Tank Leaks?

Products released from USTs generally cause damage to property or to health only after travelling, via a very complex set of physical and chemical processes, from the leaking system to a receptor population. Transport can occur in the liquid or vapor phase, as free product or dissolved in ground or surface water, in environments that may or may not be conducive to volatilization and degradation. Transport mechanisms can differ radically for different types of product. For these reasons, it is impossible to describe comprehensively the fate and transport of leaked products in the limited space available. We can, however, outline a typical course for the most common type of leak, gasoline, as follows.

When a leak begins, gasoline flows downward, first along the side of the tank, then straight down through the backfill material and then through the unsaturated zone. Depending on the volume released, the gasoline may reach the capillary zone just above the surface of the water table. Because it is less dense than water, gasoline floats on the ground-water surface, spreading out to form a "floating plume." Water-soluble compounds from the floating plume, such as benzene, then begin to dissolve into the ground water to form a dispersed plume that lengthens in the direction of ground-water movement and widens slowly. At the same time, some components of the gasoline will volatilize from the spill wherever it is in contact with air in the pore spaces of the soil or rock. The volatilized product will diffuse through the air in the soil, and may or may not reach the ground surface in noticeable amounts. Some components may also begin to degrade, or become adsorbed to the soil.

The characteristics of the floating and dispersed plumes are dependent on the hydrogeological setting. In finer grained soils, for example, the floating plume may be thicker and smaller in area. In regions of rapid ground-water flow, the dispersed plume will also move more quickly, and the floating plume may become elongated or have a greater surface area. In some types of aquifers, depending upon the chemical makeup of the aquifer media, the dispersed plume may be greatly retarded in comparison to the flow of ground water while in other aquifers a plume containing the same product may be retarded very little.

At some point, the dispersed plume may begin discharging to surface water. It may also reach a zone of low permeability at the lower limit of the surface aquifer, and slowly penetrate that layer to reach a deeper, confined aquifer.

Eventually, much of the plume will volatilize: through the soil, from surface water, from water used for drinking, showering, irrigation, or manufacturing, or even during corrective action if air strippers are used without

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[1/] Data Resources, Inc., Underground Storage Tanks, Technical/Financial/Economic Data Collection, October 2, 1985.

incineration. These airborne contaminants could reach large numbers of people, though at very low concentrations and after long periods of time.

3.B.3. Factors to Evaluate

In order to determine the need to regulate underground storage tanks and evaluate the regulatory alternatives, a "no regulation" base case that closely reflects the current state of the regulated universe must first be established. To accurately evaluate how effective a regulatory alternative may be in preventing tank leaks or in mitigating damages from tanks that may already be leaking, we need a firm understanding of several key factors regarding the current tank universe. We need to know how many tanks may currently be leaking, and we need to be able to estimate the probability of existing tanks leaking in the near future. We know that bare steel tanks corrode. The greater the number of bare steel tanks and the greater the average age of underground tanks, the greater the magnitude of possible problems from leaking tanks. Therefore, we need to know the size and the age distribution of the current population of tanks and the proportion of the current population that is bare steel tanks. The extent of risk or damages from leaking tanks depends upon the hydrogeological setting surrounding underground tanks, the proximity of tanks to ground-water wells, and the current state of leak detection and monitoring practices.

Extensive research has been undertaken by EPA to develop a better understanding of the magnitudes of tank populations, leaks, exposures, risks, and damages. Sections 3.C. through 3.F. describe the current knowledge of several key factors of the underground storage tank universe. Each of these factors plays a key role in the establishment of the base case for evaluating regulatory alternatives.

3.C. THE TANK POPULATION

Underground storage tanks covered by the regulations are found in large numbers in many sectors of the economy, and total about 1.4 million. 1/ The vast majority of these (shown in Exhibit 3.1) are used to store motor fuels and other petroleum products, with only a few percent storing chemicals. More than half of the petroleum product tanks are used by gas stations and other motor fuel retailers; the rest are spread over a spectrum of industries as shown in Exhibit 3.2.

A major portion of the current population of petroleum underground storage tanks are made of bare (unprotected) steel. A minority of tanks are of corrosion-resistant steel or of noncorroding fiberglass, as shown in Exhibit 3.3. Bare steel tanks corrode, and are commonly considered to have an expected life of between fifteen and twenty years. By this measure, a substantial portion of existing tanks are near the end of their useful lives, as shown in Exhibit 3.4. Some 40,000 petroleum tanks are replaced annually, either because they are discovered to have failed or through upgrading programs. 2/ Still other

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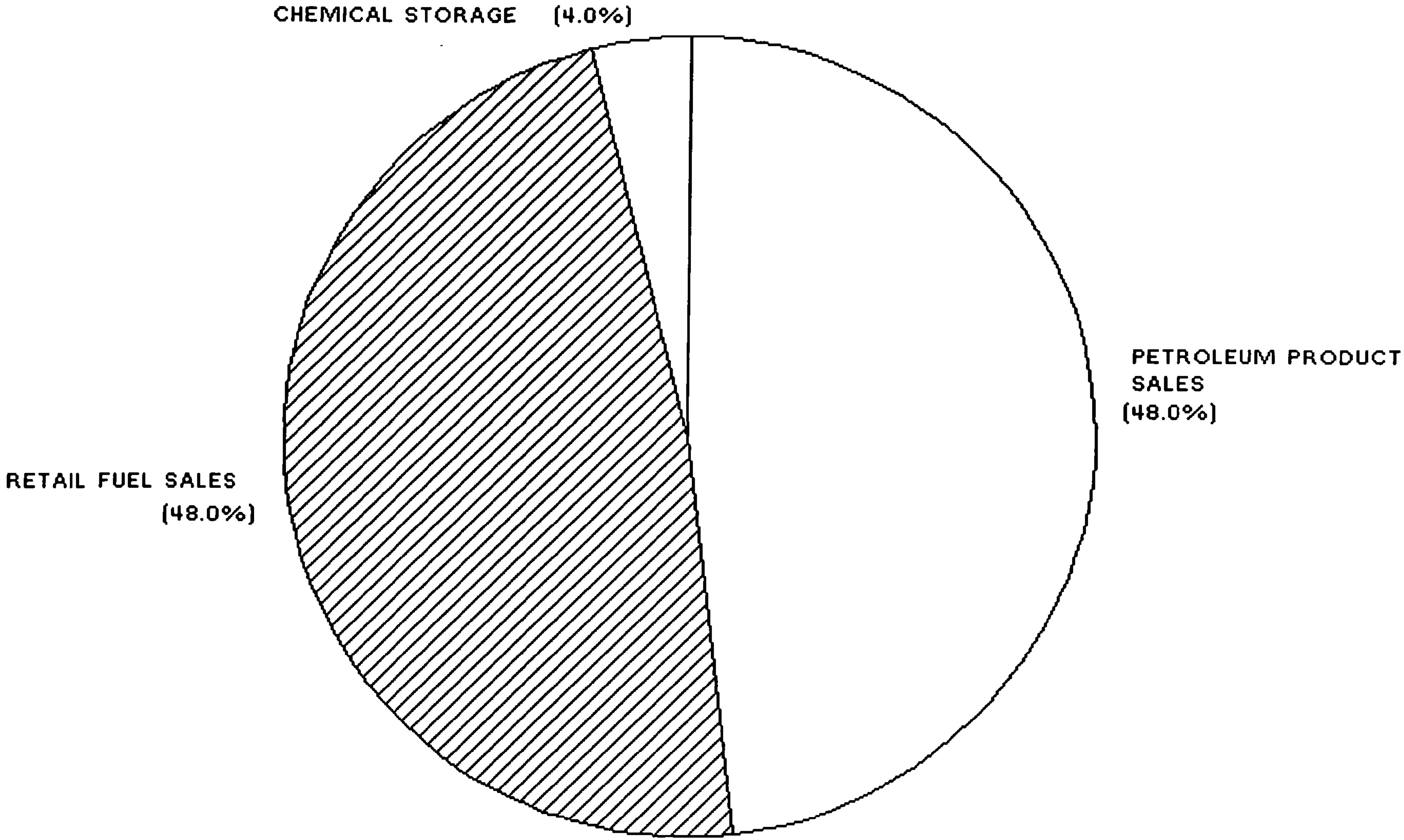
1/ EPA, Regulation of Underground Storage Tanks, Preamble and Proposed Regulations, Draft, November 24, 1986, p. 10.

2/ SCI estimate based upon The Steel Tank Institute's estimates of total tank replacements.

UNDERGROUND STORAGE TANK POPULATION BY USE



Source: EPA Office of Solid Waste, Summary of State Reports on Releases from Underground Storage Tanks, August 1986.

Exhibit 3.1

EXHIBIT 3.2

UNDERGROUND STORAGE TANKS BY INDUSTRY SECTOR

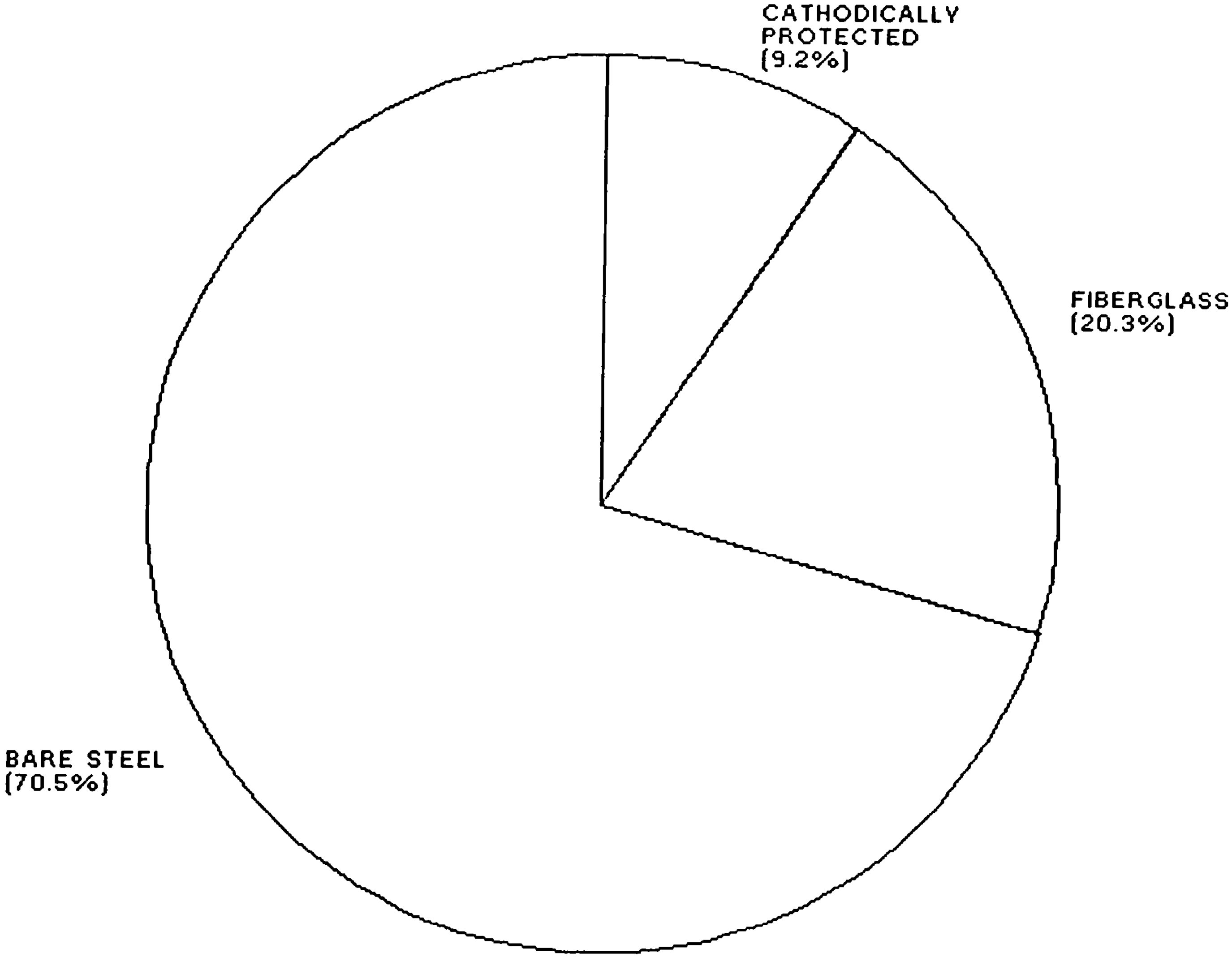
INDUSTRY SECTOR		NUMBER OF TANKS
RETAIL MOTOR FUEL SALES		695,000
PETROLEUM PRODUCT STORAGE:		
Agriculture	86,000	
Mining	14,000	
Construction	42,000	
Manufacturing	75,000	
Transportation	58,000	
Communications and Utilities	39,000	
Wholesale and Retail Trade	136,000	
Services	54,000	
Government, Military	49,000	
Government, Non-Military	98,000	
		651,000
SUBTOTAL		1,346,000
CHEMICAL STORAGE:		51,000
TOTAL		1,400,000

Source: DRI, Compliance Cost Calculations for EPA Regulation of Underground Storage Tanks, December 20, 1985.

EXHIBIT 3.3

DISTRIBUTION OF TANK TYPES

GASOLINE SERVICE STATIONS

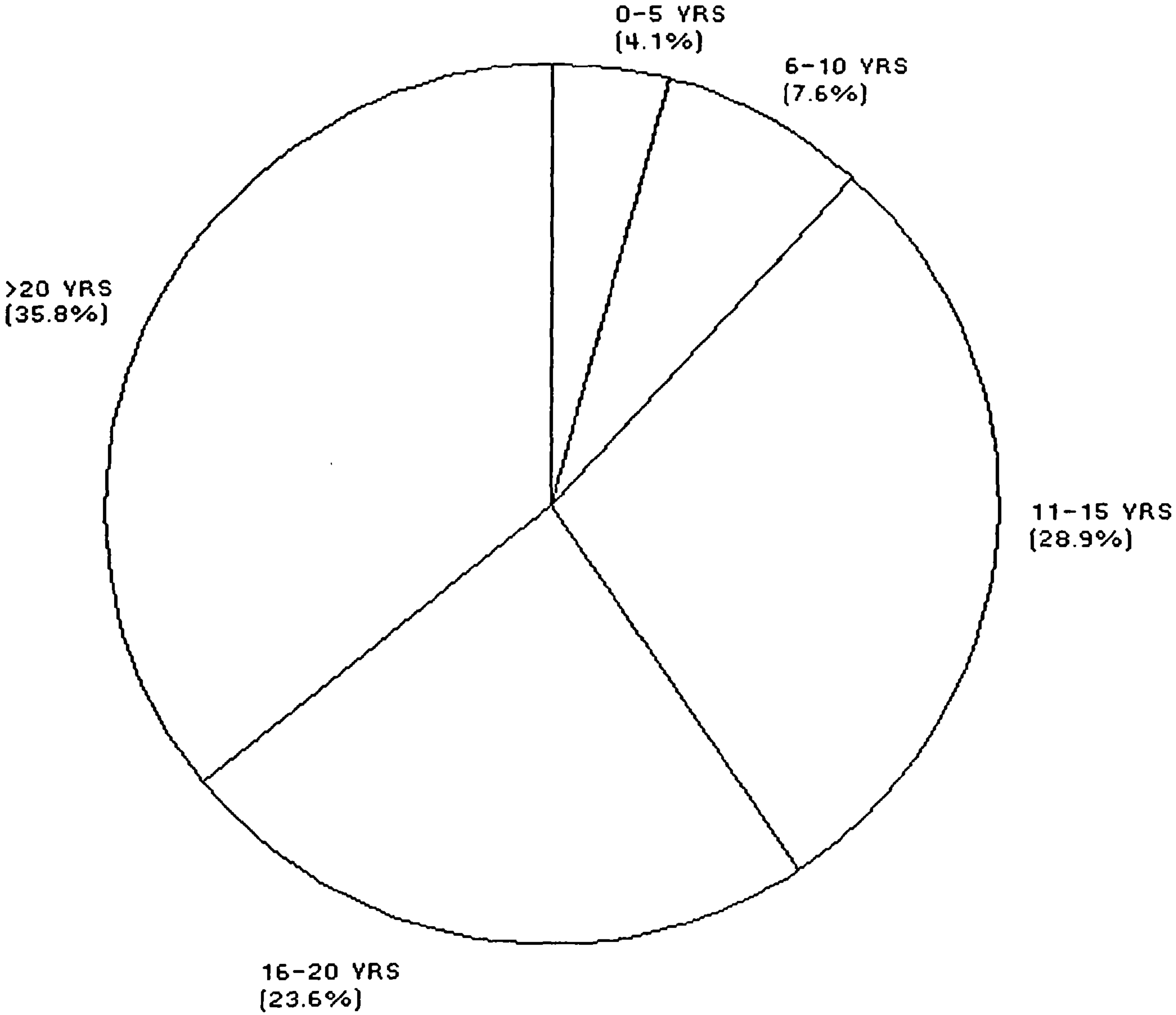


Source: DRI, Underground Storage Tanks, Technical/Financial/ Economic Data Collection, October 2, 1985

Exhibit 3.4

BARE STEEL TANK AGE DISTRIBUTION

RETAIL MOTOR FUEL ESTABLISHMENTS



Source: DRI, Underground Storage Tanks, Technical/Financial/
Economic Data Collection, October 2, 1985

tanks are retired without being replaced, as many older service stations have closed over the last decade.

3.D. LOCATION OF TANKS IN RELATION TO POPULATION AND DRINKING WATER

Knowledge about UST locations is crucial for attempts to estimate the types and magnitude of damages resulting from UST leaks. The most serious potential damage from leaking USTs (if no action is taken) is their effect on the health of users of ground water. In our analysis, more emphasis is placed upon damages to private well users than users of public ground-water systems because private wells may be more threatened by leaking USTs than public wells. Public wells can be tested more efficiently, are more likely to tap less-vulnerable confined aquifers, are less costly (on a per-gallon basis) to treat if contaminated, and can be sited in areas less likely to become contaminated.

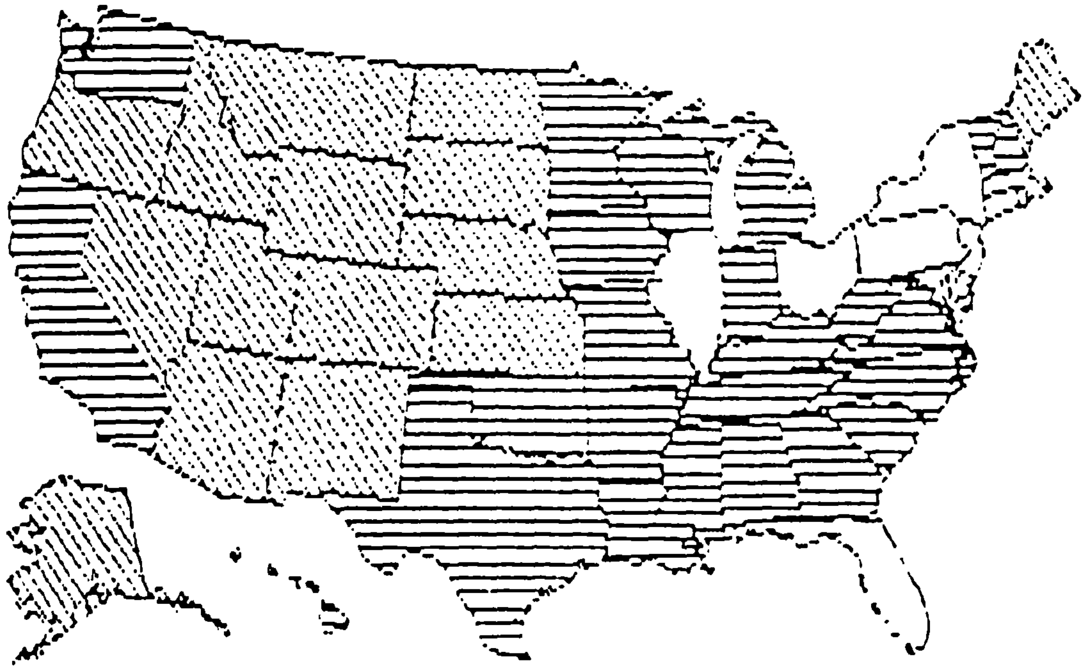
USTs are found where people are found. Where populations are dense, UST populations are dense as well. There are common-sense reasons to expect this to be true, as well as ample data. Exhibits 3.5a and 3.5b show the great similarity between state-wide UST and population densities: variations in state populations account for fully 95 percent of the variations in USTs by state. Even for geographical areas as small as zip codes, service stations are found to be closely related to populations. 1/ Exhibit 3.6 shows a plot of service stations by zip code against population by zip code, and indicates a strong degree of association between stations and population (many of the outliers, such as the circled points representing New York City, represent very atypical situations).

USTs, then, are not isolated from people in the way that, say, hazardous waste disposal facilities are isolated. Many leaks could be close to residences, other structures, or buried conduits or sewers, and therefore cause threat of fire or explosion if the leaked product is ignited. On the other hand, the immediate threat to private ground-water wells could be lower than might be expected, since, in the urban areas that contain most of the population and therefore most USTs, very few private wells are found. Exhibit 3.7 shows that while population and service stations are concentrated in areas of high population density (urban areas are shown at the left of the graph) private wells are more typically found in areas of low or moderately high population density.

Damage to public ground-water systems may show a different pattern. Though the use of ground water (as opposed to surface water) for public water systems varies from region to region, the density of public well users is still correlated with population density across the country--and this means that it is correlated with the density of USTs, at least on a state-wide basis. (Even in relatively densely populated areas, however, public water systems may be sited to avoid having USTs or other sources of contamination nearby.) Exhibits 3.8a and 3.8b show that states with high UST densities coincide to a large degree with states where ground-water users are densely packed.

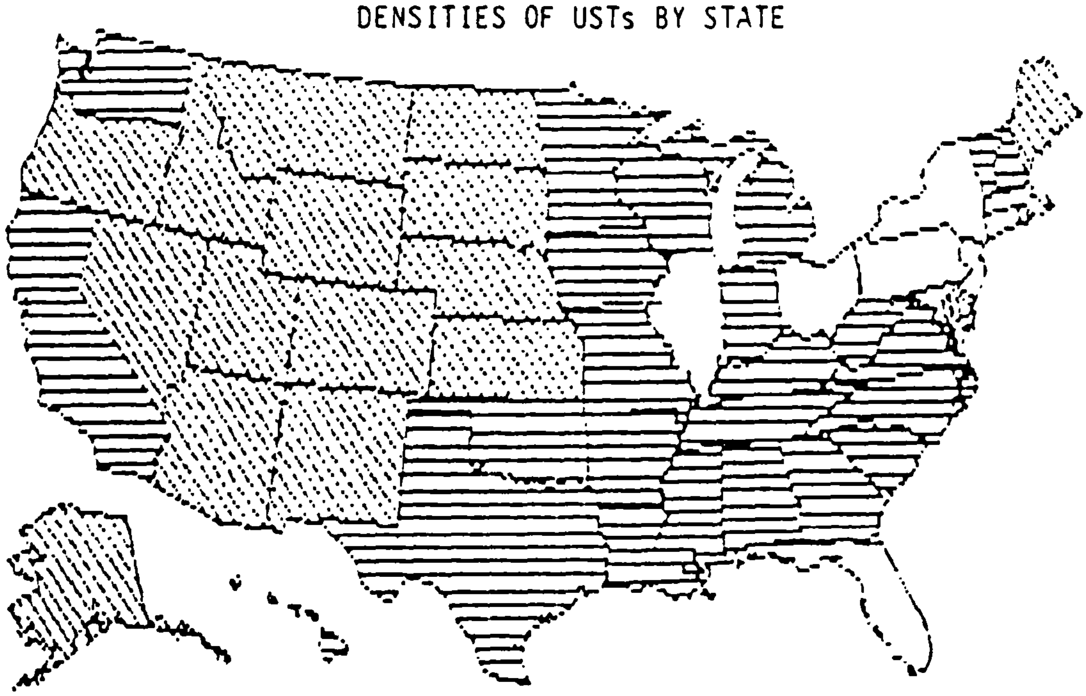
1/ A discussion of the analysis undertaken to establish the correlation between UST densities and location and population densities and location is included in Appendix B.

Exhibit 3.5a
POPULATION DENSITIES BY STATE



BLANK: Persons per square mile ≥ 165
HORIZONTAL SHADING: 165 > Persons per square mile ≥ 40
DIAGONAL SHADING: 40 > Persons per square mile

Exhibit 3.5b
DENSITIES OF USTs BY STATE

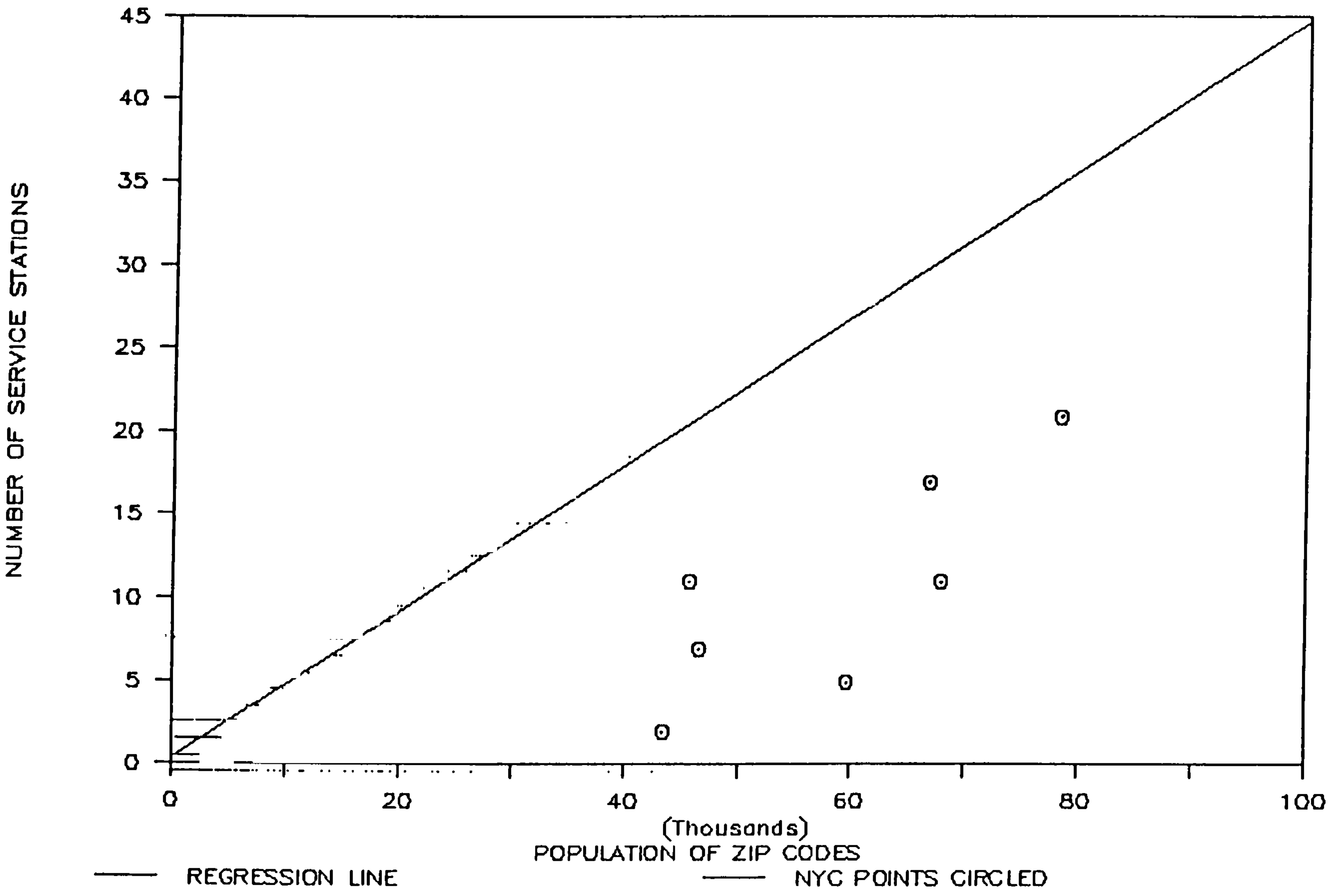


BLANK: USTs per square mile ≥ 0.34
HORIZONTAL SHADING: 0.34 > USTs per square mile ≥ 0.08
DIAGONAL SHADING: 0.08 > USTs per square mile

Source: SCI, based on 1980 census data.

Exhibit 3.6

PLOT OF SERVICE STATIONS AND POPULATION

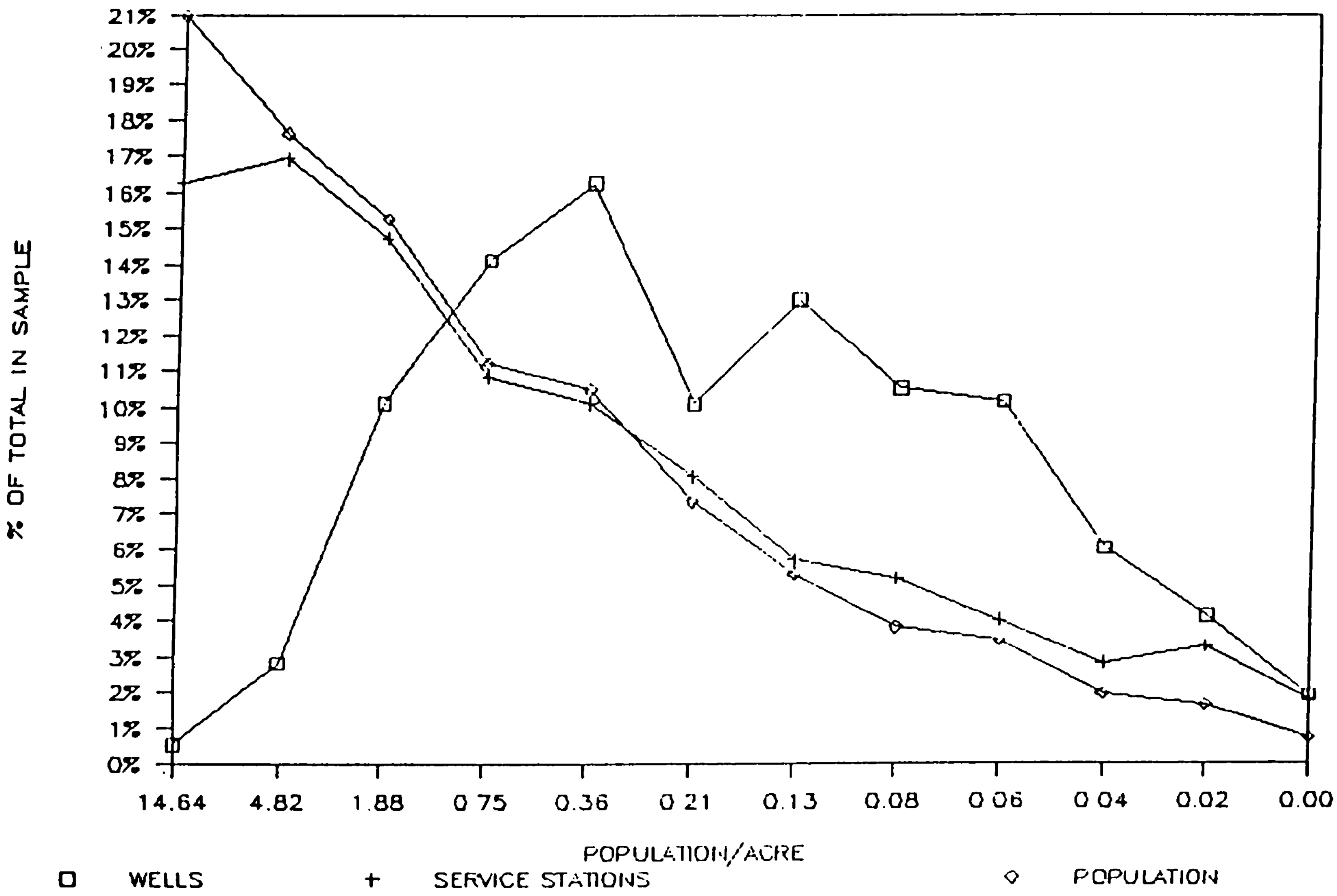


Source: SCI estimate from 1980 census data.

Exhibit 3.7

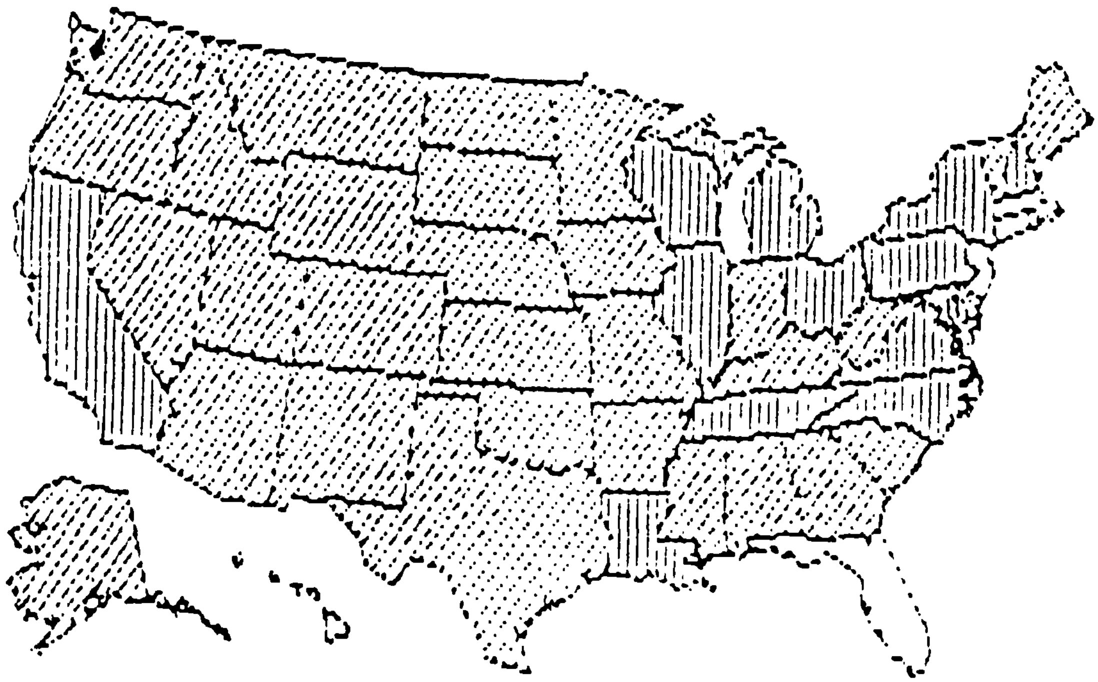
DISTRIBUTION OF WELLS, STATIONS, POP.

ACROSS AREAS OF DIFFERING POP DENSITY



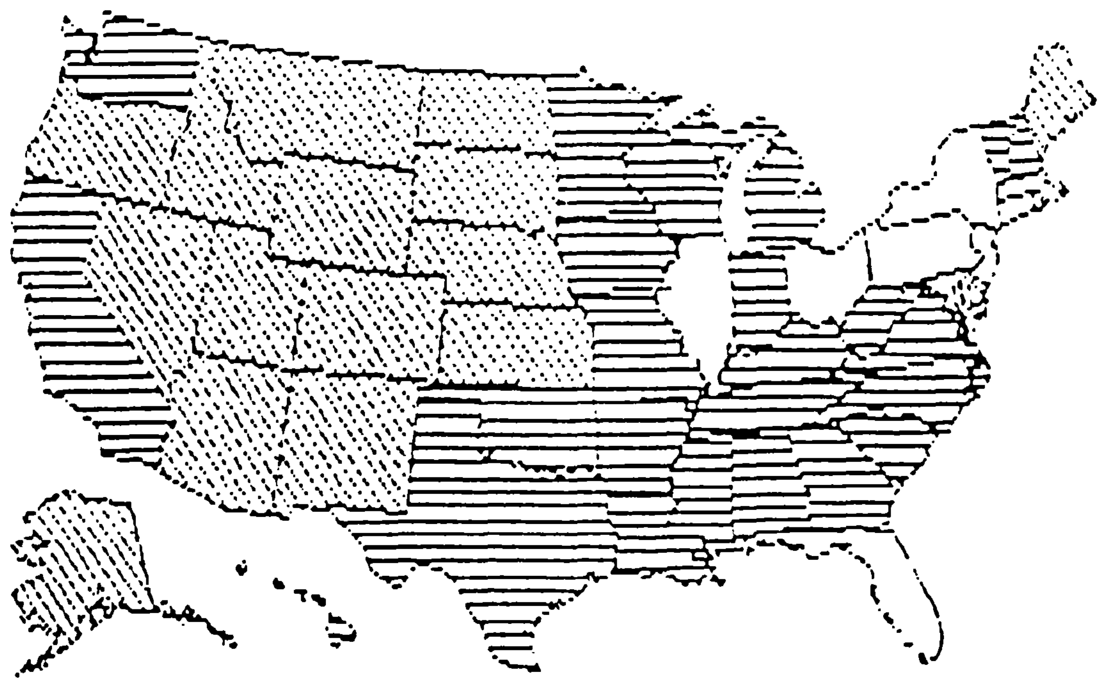
Source: SCI and PRA Estimates Using UST Model

Exhibit 3.8a
DENSITIES OF GROUND-WATER USING POPULATION BY STATE



BLANK: Persons per square mile ≥ 150
VERTICAL SHADING: 150 > Persons per square mile ≥ 50
DIAGONAL SHADING: 50 > Persons per square mile

Exhibit 3.8b
DENSITIES OF USTs BY STATE



BLANK: USTs per square mile ≥ 0.34
HORIZONTAL SHADING: 0.34 > USTs per square mile ≥ 0.08
DIAGONAL SHADING: 0.08 > USTs per square mile

Source: SCI, based on 1980 census data.

3.E. Importance of Hydrogeological Settings

Information on the physical characteristics of the sites where USTs are found is also important to allow estimates of the number of tanks leaking, the formation of plumes and the movement of contaminants. Currently, USTs are distributed across eleven distinct, USGS-identified, hydrogeologic regions nationwide (see Exhibit 3.9), and, within these regions, in distinct hydrogeological settings. Leaks in some of these settings are much more threatening (in terms of likelihood of damages) than in others, and cross tabulation of the USTs by setting with proximity of water use will allow a truer picture of site-by-site risks to emerge.

3.E.1. Hydrogeological Factors Affecting Failure Rates

There are two hydrogeological factors that have a major effect on leak rates: aggressiveness of the soil and water table depth. The aggressiveness of the soil is a function of several physico-chemical properties including soil pH, sulfide concentration, and oxidation/reduction potential. The UST Simulation Model and several independent analyses have characterized tank corrosion as one of the chief failure mechanisms for unprotected tank systems in terms of both frequency and release volume. For unprotected steel tanks, the rate of corrosion is accelerated in aggressive soils. Natural soil materials vary widely in terms of the factors that affect aggressiveness, and like other hydrogeologic parameters, there can be significant variations on a local level.

Water table depth (also known as unsaturated zone thickness or vadose zone thickness) also plays an important role in determining leak rates. When the water table is permanently or occasionally higher than the bottom of the tank it has the following effects:

- Periodic or permanent inundation affects the rate of corrosion, depending on the quality of the ground water;

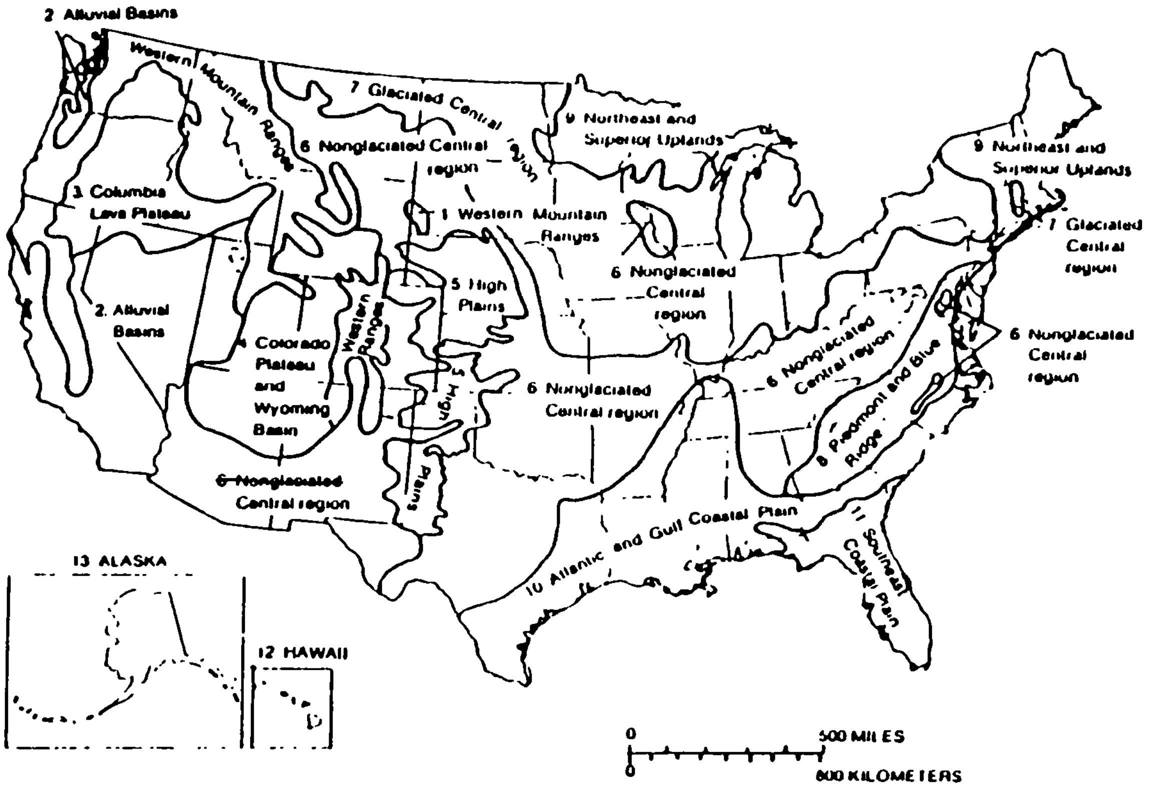
- If the tank is not anchored by means of a ballast and strap system, its buoyancy can cause it to shift, resulting in ruptures in the piping system;

- If the water table is generally or always above the gasoline level in the tank, a leak in the tank will result in water flowing in rather than product flowing out (this is probably not true for the pipe system, which is under pressure). In this situation, tank leaks are unlikely to result in any health or environmental damage, and are likely to be discovered and corrected without government intervention.

3.E.2. Hydrogeological Factors That Affect Characteristics of the Floating Plume

There are three primary factors that control the size of the floating plume: permeability of the vadose, or unsaturated, zone material, pore size distribution of the vadose zone material, and water table depth. In permeable material, the gasoline can move more rapidly, and the plume can spread out so that it is relatively wide and shallow. If large pore sizes are relatively abundant, the capillary forces that restrict the downward flow of gasoline are not as strong; otherwise, the fine-grained material can essentially 'lock up' the gasoline, preventing it from reaching the water table. And if the water table

Exhibit 3.9



Ground-water regions of the United States (After Heath, 1984).

is deep, a floating plume may not form, provided that the vadose zone comprises relatively finegrained material.

3.E.3. Hydrogeological Factors Affecting Characteristics of the Aqueous Plume

Several hydrogeologic factors control the introduction and movement of gasoline contaminants in aqueous plumes and the vulnerability of aquifers to contamination:

- Whether the aquifer is confined or unconfined;
- Ground water velocity;
- Aquifer thickness; and
- Amount of organic carbon present in the aquifer material.

The most important of these is probably whether the aquifer is confined or unconfined. When the uppermost surface of an aquifer coincides with the water table (i.e., the boundary between the vadose zone and the saturated zone), the aquifer is unconfined. Unconfined aquifers are recharged by infiltrating rain water, and are relatively vulnerable to contamination from sources like USTs that release pollutants directly above them.

Confined aquifers are bounded above by an aquitard, i.e., a geologic unit with low permeability that limits water flow. Confined aquifers are generally recharged in areas where the confining layer (overlying aquitard) is absent. These aquifers are less vulnerable to UST contamination because:

- The floating plume will not come in direct contact with the aquifer. Benzene and other constituents will slowly diffuse and advect through the aquitard, but the mass flux (pollutant loading rate) will be lower than for an unconfined aquifer.
- Contaminants are generally less mobile in aquitards. Organic carbon content of clays and silts (common aquitard materials) is relatively high, resulting in strong adsorption and retardation of organic pollutants.
- The aquifer may be pressurized, i.e., hydraulic head is generally higher than the base of the aquitard, so that the water in the aquifer is 'pushing' upward.

Many of the aquifers that are used for current drinking water supplies are confined. Confined aquifers are sometimes preferred over unconfined because they are more dependable during droughts and can provide high well yields. This is particularly important for municipal well systems. Private drinking water wells do not require high well yields, and thus can often tap unconfined aquifers (saving on well drilling costs, which are increased with well depth).

Exhibit 3.10 provides preliminary estimates of the percentage of public and private wells drawing from confined aquifers in each of ten hydrogeologic regions identified by USGS. In some regions, such as the High Plains and Western

Exhibit 3.10

Percentages of Ground Water Used from Confined Aquifers for Each Ground-Water Region [1]

Ground-Water Region	Percentage of Ground-Water Used from Confined Aquifers	
	Municipal Supply	Domestic Wells
Western Mountain Ranges	0 - 5%	0 - 5%
Arid Basins	45 - 50%	0 - 5%
Columbia Plateau	40 - 45%	10 - 15%
Colorado Plateau	90 - 95%	20 - 25%
High Plains	0 - 5%	0 - 5%
Central	5 - 10%	5 - 10%
Glaciated Central	50 - 55%	20 - 25%
Unglaciated Appalachian	0 - 5%	0 - 5%
Glaciated Appalachian	10 - 15%	0 - 5%
Coastal Plain	90 - 95%	65 - 70%

1/ Source: ICF, Inc. estimates

Mountain Ranges, almost all wells tap unconfined aquifers. In other regions, like the Atlantic and Gulf Coastal Plain, most wells tap confined aquifers.

Ground water velocity also determines aqueous plume characteristics. Velocity is a function of hydraulic gradient and permeability. It controls time of travel (TOT) and thus the potential for degradation, and also bears on the amount of water available for dilution. In very low-velocity systems, leaks are likely to be detected before contaminants reach wells. In very high-velocity systems, more wells may be affected, but the contaminants are likely to be in more dilute concentrations. Aquifer thickness also affects dilution rates; thicker aquifers are expected to exhibit lower contaminant concentrations. Velocities range over about five orders of magnitude, although most aquifers have velocities on the order of 0.01 m/day to 5 m/day; aquifer thickness is generally in the range of a few meters to 100 meters.

The fraction of organic carbon (foc) in the aquifer material also affects aqueous plume characteristics. Benzene and other organic contaminants move at velocities that are somewhat slower than that of ground water; the higher the foc, the more strongly they are adsorbed, and the slower they move. This effect is similar to that of ground water velocity on plume characteristics. The foc's for aquifer materials vary over about two orders of magnitude.

3.E.4. Distribution of Hydrogeological Settings

Because damages caused by leaking USTs are so highly dependent on hydrogeological settings, we attempted to develop a first cut at the distribution of some important parameters across the nation. One mapping of hydrogeological settings that is a useful starting point is the USGS (Heath) ground-water regions (shown previously in Exhibit 3.9). USGS regions distinguish hydrogeological settings across the nation according to large-scale variations in geologic and ground water characteristics. However, there is still significant variation in hydrogeological settings within each USGS Region.

As we have explained, the plumes resulting from USTs vary widely with ground water velocity, vadose zone medium, and depth to ground water. Therefore, we developed a distribution of hydrogeological settings in categories which represent combinations of these three variables. Exhibit 3.11 presents the number of underground storage tanks located in each of 27 hydrogeological settings (based on all possible combinations of the three variables, each subdivided into three ranges). The information in Exhibit 3.11 is useful for analyzing cost and effectiveness of regulatory alternatives in areas of different hydrogeological vulnerability. As outlined above, areas which have USTs in vulnerable hydrogeological settings, and are therefore potentially at higher risk, are those areas of the country which have unconfined aquifers with high water tables (not including those settings where the water table is above the bottom of the tank), high ground water velocities and more permeable soil types.

However, the distribution of hydrogeological settings alone does not adequately characterize potential risks from leaking tanks. A vulnerable hydrogeological setting may contain few underground storage tanks or be situated where ground water is not suitable for use, and therefore few, if any, benefits will accrue from regulations for that setting. Ground water may actually be more threatened in an area with a high density of USTs even if the hydrogeological setting there is intrinsically less vulnerable.

HEATH REGION

HYDRO-GEO[2]/REGION SETTING	REGION 1	REGION 2	REGION 3	REGION 4	REGION 5	REGION 6	REGION 7	REGION 8	REGION 9	REGION 10	REGION 11	REGION 12	REGION 13	% TOTAL
1,1,1	0	0	0	0	0	10959	0	0	0	0	0	0	0	9.36
1,1,2	0	0	0	0	0	347	0	0	0	0	0	0	0	0.30
1,1,3	0	0	0	0	0	0	0	0	0	0	966	0	0	0.85
1,2,1	0	0	0	0	0	0	0	0	5858	0	0	0	0	5.14
1,2,2	0	0	0	0	0	0	4344	4689	514	3250	0	0	0	11.2
1,2,3	0	0	0	0	0	2106	4681	0	967	0	0	0	0	6.8
1,3,1	0	0	0	0	0	0	118	0	23	0	0	0	0	0.1
1,3,2	115	0	11	0	0	0	10635	3	0	333	3852	0	0	13.12
1,3,3	1203	47	0	48	68	1287	1283	2075	735	9883	1635	251	75	16.32
2,1,1	0	0	0	731	0	1288	0	0	0	0	0	0	0	1.77
2,1,2	79	0	324	0	0	541	0	0	0	0	0	0	0	0.80
2,1,3	0	0	0	0	0	1668	0	253	0	0	0	0	0	1.69
2,2,1	0	0	0	0	0	0	1213	0	0	0	0	0	0	1.06
2,2,2	0	0	0	0	0	0	7075	0	0	0	0	0	0	6.21
2,2,3	0	0	0	0	0	0	741	0	4088	0	0	0	0	4.24
2,3,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2,3,2	11	15444	0	0	238	0	42	0	0	0	0	0	0	13.81
2,3,3	0	0	0	0	109	0	0	0	0	0	0	0	0	0.01
3,1,1	0	0	0	0	0	478	0	0	0	0	0	0	0	0.42
3,1,2	286	0	0	0	0	0	0	0	0	0	0	0	0	0.25
3,1,3	101	0	0	0	0	0	0	0	0	0	0	0	0	0.09
3,2,1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,2,2	0	0	0	0	0	0	0	0	0	3173	0	0	0	2.79
3,2,3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3,3,1	0	0	0	0	0	0	0	0	685	0	0	0	0	0.60
3,3,2	0	33	0	0	0	0	0	0	0	0	0	0	0	0.03
3,3,3	0	0	221	0	972	0	0	0	0	0	0	0	0	1.05
Other	1232	335	113	0	0	0	0	197	109	0	0	115	0	1.84
TOTALS	3027	15859	669	779	1387	18647	30132	7217	12979	16639	6453	366	75	
% TOTAL	2.66	13.92	0.59	0.68	1.22	16.37	26.45	6.33	11.39	14.60	5.66	0.32	0.07	

1/ See Heath Region Map, Page 3-14

2/ Depth to Ground Water,
1 = 0 - 10 Meters
2 = 10 - 20 Meters
3 = > 20 Meters

Vadose Zone Medium,
1 = S. Stone, Lime Stone, Shale
2 = Silt/Clay
3 = Sand & Gravel

Ground Water Velocity
1 = < 0.32 Meters/Day
2 = 0.32 - 2.23 Meters/Day
3 = > 2.23 Meters/Day

Cross-referencing the hydrogeological settings and tank densities by USGS Region can provide an idea of which areas of the country have relatively vulnerable hydrogeological settings and high concentrations of underground storage tanks. For example, a relatively high proportion of USTs are found in USGS Region 7, but about one-half of the underground storage tanks in USGS Region 7 are located in clay soils. Clay soils impede the flow of leaking petroleum to the ground water table, and therefore, stringent controls for tanks in clay soils may not be as cost-effective as stringent controls for tanks in other soils.

3.E.5. Summary

Hydrogeologic characteristics have a strong influence on leak rates from USTs, characteristics of floating plumes, and characteristics of aqueous (dispersed) plumes. These characteristics vary widely on a regional and local basis. Some aquifers are much more vulnerable to contamination than others, and we can identify some settings where leaks are not likely to cause significant problems (e.g., water table permanently higher than the top of the tank).

Risks from leaking underground tanks cannot, however, be predicted on the basis of the hydrogeological setting alone. As discussed earlier, tank density, population density, and ground water usage also play vital roles in establishing the level of potential risks from leaking tanks.

3.F. CURRENT PRACTICES

3.F.1. Leak Detection

There is no evidence that any form of leak detection or leak monitoring, other than manual inventory control, is widely practiced by current tank owners. According to EPA's Release Incident Survey, visual detection and detection by odor or vapors are the most commonly reported methods of detecting leaks from underground tanks. In fact, more than 65 percent of reported releases were detected either visually or due to the presence of odor or vapor. 1/ This evidence suggests that leak detection equipment is not widely used by the current population of tank owners. Inventory control may or may not be widely practiced by tank owners, but evidence reported by both the Release Incident Survey and the Retail Motor Fuel Tank Survey suggests that if inventory control is practiced, it is not done often or well, and has not figured prominently in the detection of tank leaks.

3.F.2. Responses to Tank Leaks

As mentioned in Chapter 2, after a leak has been detected a choice can be made to accept further damages, or to take steps to mitigate these future damages. The following discussion covers three potential responses: do nothing, clean-up, and treatment or use of alternative water sources.

<u>Do Nothing</u>: If the source is cut off, the leaked product could continue to migrate. In many cases it would form a plume in, or on top of, the surficial aquifer if it had not already done so before detection, and the plume would

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1/ EPA Office of Underground Storage Tanks, <u>Summary of State Reports on Releases from Underground Storage Tanks</u>, August 1986.

proceed to migrate, slowly dispersing and possibly affecting wells before discharging to surface water. As time went on, the concentrations of contaminants in additional affected wells would drop. The chance that a public system would be encountered would rise over time, though the odds that this will happen before the concentrations in the plume are greatly diluted are small in the typical case.

Of course, if the plume were to intercept a dense private well field, a public well field, or cause other damages, then there may be interest in exploring ways to avoid these damages. These potential responses are discussed below.

Undertake Clean-up: Corrective action can take several forms. The contaminated soil in the unsaturated zone might be excavated and treated. Or the floating plume could be removed by sinking wells just into the saturated zone, and using an oil/water separator to recover the free product. This step may or may not be accompanied by some form of treatment of the water (which will have some gasoline dissolved in it) pumped up with the free product. This step would largely eliminate the source for the dispersed plume, which would then fall more rapidly in concentration as it grew. Costs for this action are quite variable. The removal of a large floating plume could cost several hundreds of thousands of dollars. Costs of removing the floating plume from a smaller release might be under $100,000. EPA is in the process of refining its estimates of clean-up costs.

Removal of the dispersed plume could eliminate much of the remaining risk, though this could add substantially to costs. Some large spills have been known to cost in the millions of dollars to clean up, where the goals for the purity of the ground water after the clean-up have been strict.

Treat Drinking Water or Use Alternatives: Upon discovering that their drinking water is contaminated, residents of a home with a tainted well have various alternatives. They could continue to drink the contaminated water and bear the health risks, or they could switch to bottled water for drinking and cooking. Bottled water would avoid about half of the health risk, as much of the risks from inhalation would remain.[1]/ Alternatively, the residents could purchase carbon adsorption units to treat their water, eliminating nearly all the health risks as long as they were maintained properly. Finally, the residents might be able to drill a new or deeper well to clean water or tie into a municipal water system.

If a public water supply well were to be affected, risks could again be accepted or eliminated via treatment, at an annualized cost in the tens or hundreds of thousands of dollars, depending on the size of the system. In a typical case, the discounted cost of a treatment system for a public system would be low, given that decades could be expected to pass before the plume reached public wells and treatment would be necessary.

1/ EPA Office of Drinking Water, Economic Impact Analysis of Proposed Regulations to Control Volatile Synthetic Organic Chemicals in Drinking Water, October 1985.

3.F.3. State Regulations

Forty-two states have at least some form of UST legislation in place. Most of these state programs reflect state fire code restrictions for petroleum storage and petroleum industry codes and recommended practices. Approximately twelve states have comprehensive programs for regulating underground storage tanks. States with comprehensive programs are, for the most part, states with relatively high ground water usage.

Since the majority of states do not have comprehensive UST programs regulating tank types or leak detection and monitoring practices, state regulatory requirements are not incorporated into the established base case. EPA did, however, evaluate state regulatory approaches and sought state input when establishing its regulatory framework and in structuring the regulatory alternatives for underground tanks.

3.G. THE BASE CASE

The base case depicts, or illustrates, the alternative of no federal regulation, or what will prevail in the absence of any regulation. The base case is very important in the analysis of the regulatory alternatives because it provides a base level from which we can evaluate the incremental costs and benefits of each regulatory alternative. By comparing each alternative with the established base case we obtain the incremental costs and benefits of the alternative over the alternative of no regulation.

3.G.1. Characteristics of the Base Case

All the available information that is outlined in the previous sections of this chapter was evaluated to establish the "no regulation" base case used in analyzing the costs and benefits of EPA's regulatory alternatives. The base case consists of 1.4 million tanks: 89% are constructed of bare (unprotected) steel and 11% are constructed of fiberglass reinforced plastic (FRP).[1] The DRI tank age distribution (presented in Exhibit 3.4) is the assumed age distribution of tanks in the base case. As will be explained below, a certain level of base leak detection (manual or sensory) is incorporated into the base case, but no supplemental leak detection or monitoring equipment is included in the base case. All replacement tanks, or newly installed tanks, are single-wall, coated and cathodically protected steel tanks. This tank type is the minimum tank construction requirements allowed under the current interim prohibition for new tanks.

3.G.2. Proportion of Tanks Leaking

EPA's UST Simulation Model provides a method for assessing what proportion of the UST universe is currently leaking. Using the model, we can simulate the lives of tanks of different types and different ages. By repeating the simulation of individual tanks many times, we can develop an understanding of what

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[1] EPA Office of Pesticides and Toxic Substances, Underground Motor Fuel Storage Tanks: A National Survey, Vol. 1 Technical Report, May 1, 1986, p. 2-10. The distribution of tank types in Exhibit 3.3 was taken from DRI's report of October 3, 1985. We chose to use EPA's survey results in our analysis.

happens to a population of identical tanks in the same situation. We can also compare model runs of different tank types to draw conclusions about the effects of different tank technologies, and the correlation between tank characteristics and release profiles. We use model runs simulating different tank types, tank ages and environmental situations to scale the model results to the current tank population.

The modeling approach to assessing the current situation for underground storage tanks uses information that is currently available, but also requires that explicit assumptions be made when information is not available. The UST Model uses currently available data regarding tank characteristics and failure probabilities, and incorporates physical properties of tank construction materials and the tank's environmental surroundings. Best engineering judgement is used to provide needed assumptions when current data is unavailable. The model does require that assumptions and data be used in an explicit and consistent manner and, if there is uncertainty about particular assumptions, the model can be used to conduct sensitivity analyses over the range of uncertainty in the assumptions.

One assumption that is very important in the UST simulation is the assumption made in regard to the level of base detection. Base detection is the assumed level of leak detection that is currently in place at tank facilities. Some leaks will be detected in the absence of regulation, without leak detection equipment and without stringent inventory control. Some leaks are detected by product inventory. Other leaks are detected because water leaks into a tank, petroleum appears in the basement of a nearby property, or a nearby ground-water well is contaminated. The base detection assumption in the UST model is an attempt to simulate these current practices or the current level of leak detection.

We represent base detection in the UST Model by adjusting the effectiveness of monthly inventory control. The level assumed for base detection significantly affects the conclusion that can be drawn about the number of underground tanks that are currently leaking undetected. The better the level of base detection is assumed to be, the fewer the number of tanks that can be concluded to be leaking undetected. If we assume that base detection is virtually nonexistent, we can conclude that a large percentage of the current tank population is leaking and will not be detected without requiring more stringent levels of leak detection.

The level of base detection is entered into the UST Model as a percentage of tank capacity for daily and weekly detection, and is entered as a percentage of monthly throughput for monthly detection. For example, a base detection level of 10% - 10% - 3% means that a leaking tank will be detected if 10% of the tank capacity is lost in a day, if 10% of the tank capacity is lost in a week, or if 3% of the monthly throughput is lost in a month. Exhibits 3.12-3.14 illustrate the effect of different assumptions for base detection upon the percentage of tanks currently leaking and the distribution of release volumes for bare steel tanks. The exhibits illustrate three levels of base detection: 4% of monthly throughput, 3% of monthly throughput and 2% of monthly throughput. The level of performance attributed to base detection has an important implication for evaluating regulatory alternatives. The better base detection is, the less value is accrued from technical standards imposed by government regulation. If we compare the modeling results to survey data from the EPA's National Survey of Underground Motor Fuel Storage Tanks and the National Release Incident Survey, a base detection level that assumes that a loss of 3% of monthly tank throughput can be detected in a month calibrates the model to closely reflect the current UST situation depicted by these surveys. This level of base detection (10% - 10% - 3%) is the assumption used throughout our analysis.

As illustrated in Exhibits 3.12-3.14, a more stringent base detection assumption results in a smaller estimated proportion of facilities with undetected leaks. Relaxing the base detection assumption results in a higher prediction of undetected leaks, or a decrease in the proportion of tight facilities, and larger release volume estimates. By assuming a more stringent level for base detection (Exhibit 3.12) we are assuming that fewer gallons of product are released before a leak is detected. Therefore, leaking tanks are detected more quickly, less tanks may have undetected leaks at any given time, and the distribution of release volumes will show a greater number of small release volumes relative to large release volumes. In contrast, if we assume a less stringent level for base detection (Exhibit 3.14), more gallons of product will be released before a leak is detected. The result is a greater number of undetected leaks (or fewer tight facilities) and larger release volumes.

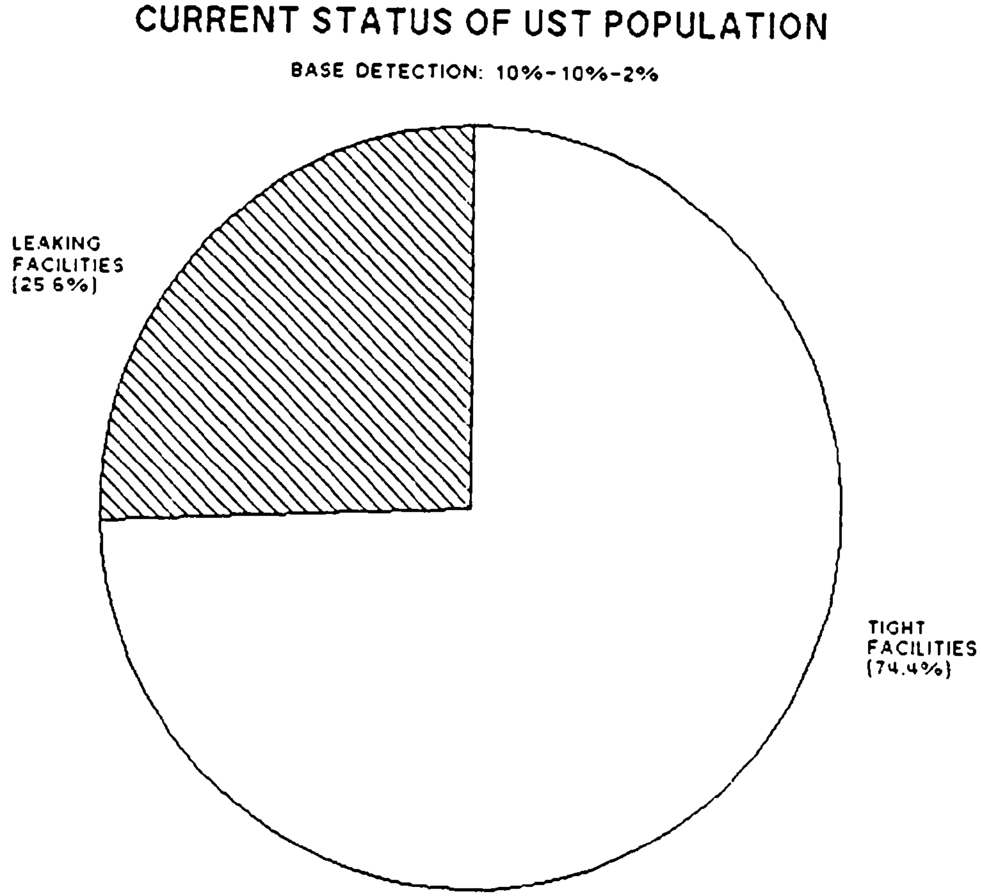
3.G.3. Predicted Status of Tanks

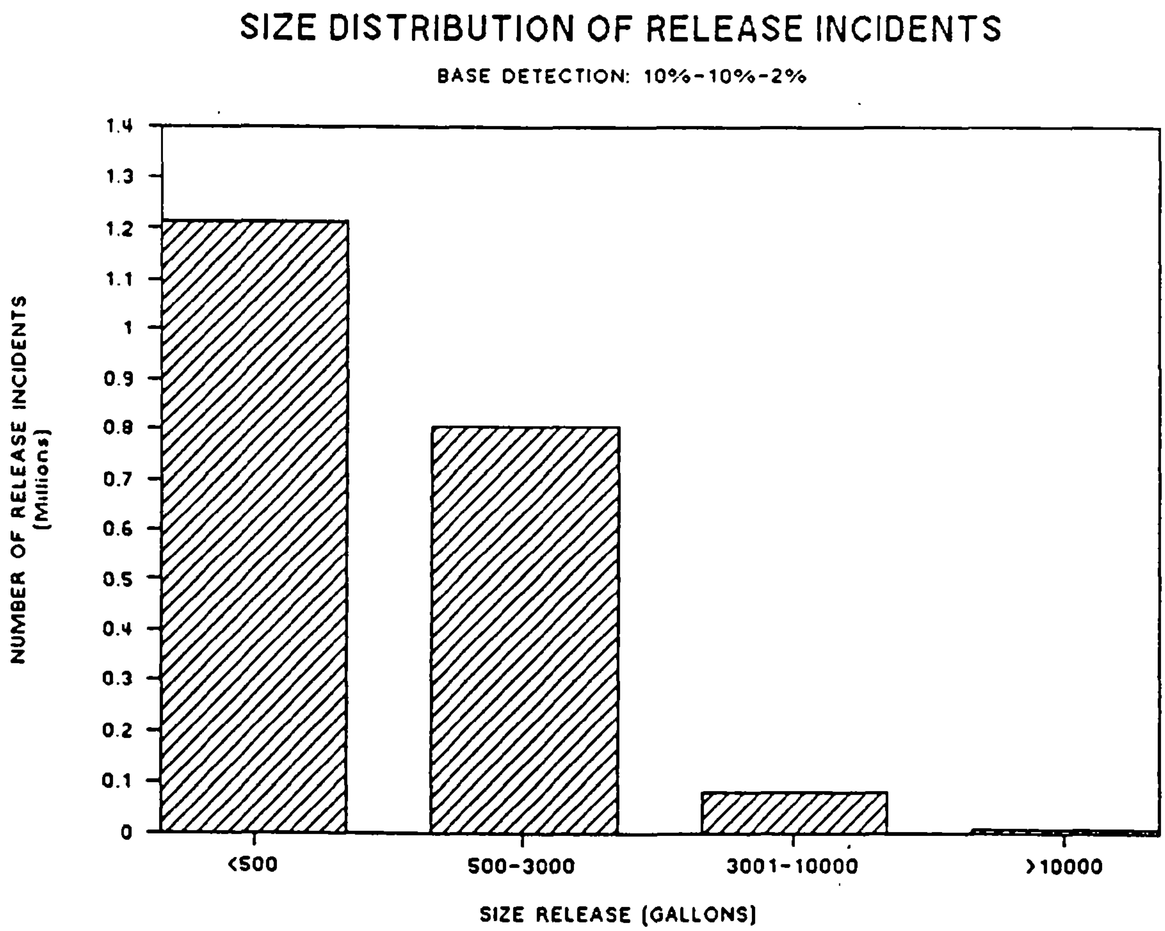
The UST Simulation Model allows us to use the information available regarding the current tank universe to predict the status or failure state of the tank universe now, and over a given period of years. Exhibit 3.15 illustrates the model's predicted status of bare steel tanks for the base case. This exhibit shows the proportion of the current population of tanks that are either leaking because of pipe failures or tank failures, or are tight.

Exhibit 3.15 depicts the model's predicted status of the current population of bare steel tanks, given a particular set of inputs and assumptions. These inputs and assumptions reflect EPA's best available information regarding the current characteristics of the UST population. Not every aspect of the UST universe can be accounted for, and therefore, the predicted status of the bare steel tank population shown in Exhibit 3.15 is only a best estimate. The actual numbers of leaking and tight UST facilities may vary due to the lack of full or precise information. For example, EPA is aware that some of the major oil companies, and in fact some independent dealers, have undertaken voluntary tank upgradings or tank replacement policies. Because the Interim Prohibition requires all new tanks, or replacement tanks to be corrosion resistant, the effect of these voluntary upgrading policies is to reduce the number of existing bare steel tanks and therefore reduce the likelihood of facility failures.

Because little information is known about the extent of, or the details of, voluntary upgrading or tank replacement policies, these policies are not included in the base case assumptions, and the base case and options were modeled assuming no voluntary replacement policies. The result is that the number of tanks predicted to be leaking could be overstated to the extent that a number of bare steel tanks are being replaced before they leak through these voluntary upgrading and tank replacement policies.

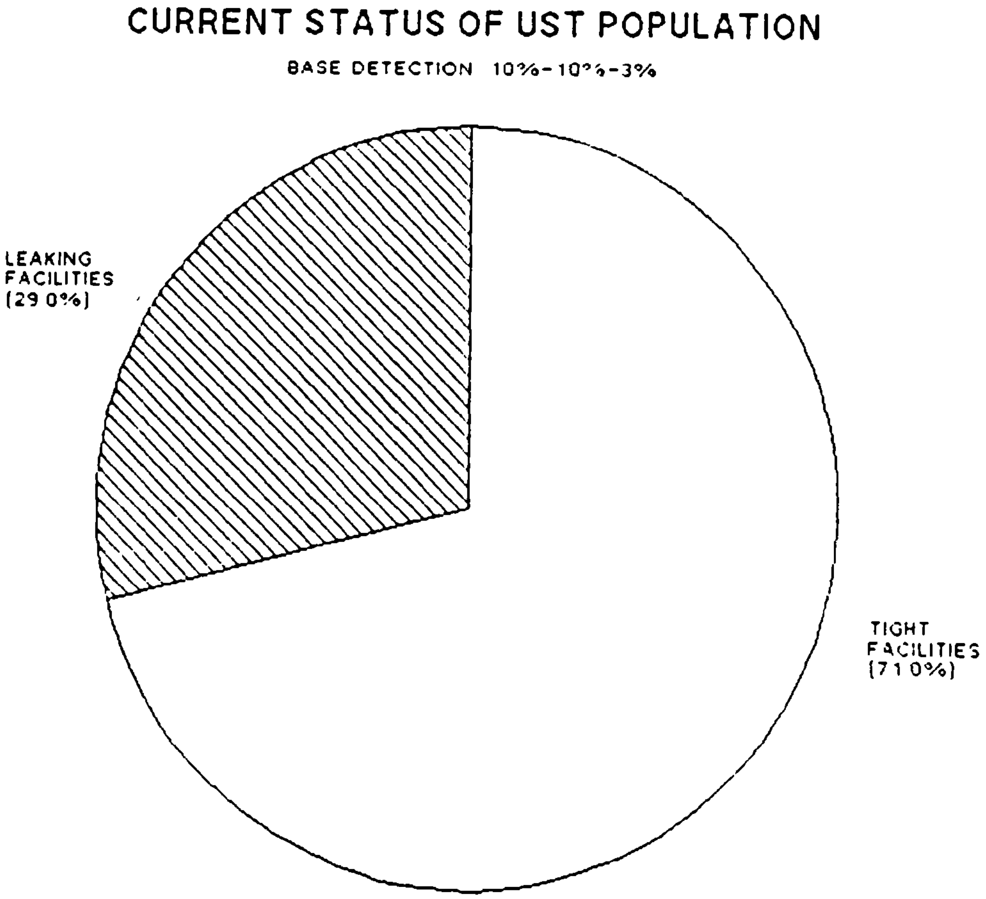
Exhibit 3.12

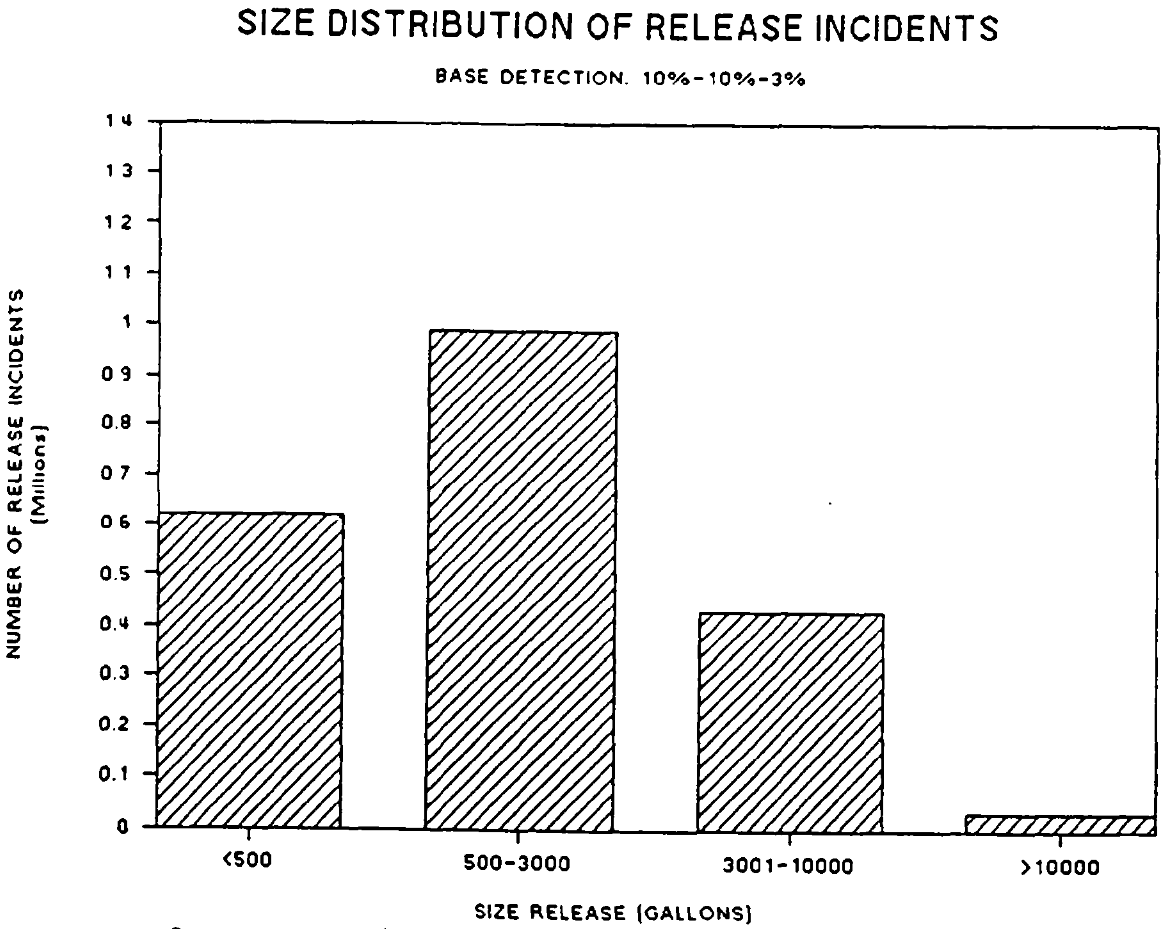




Source: SCI Estimates using UST Model results.

Exhibit 3.13



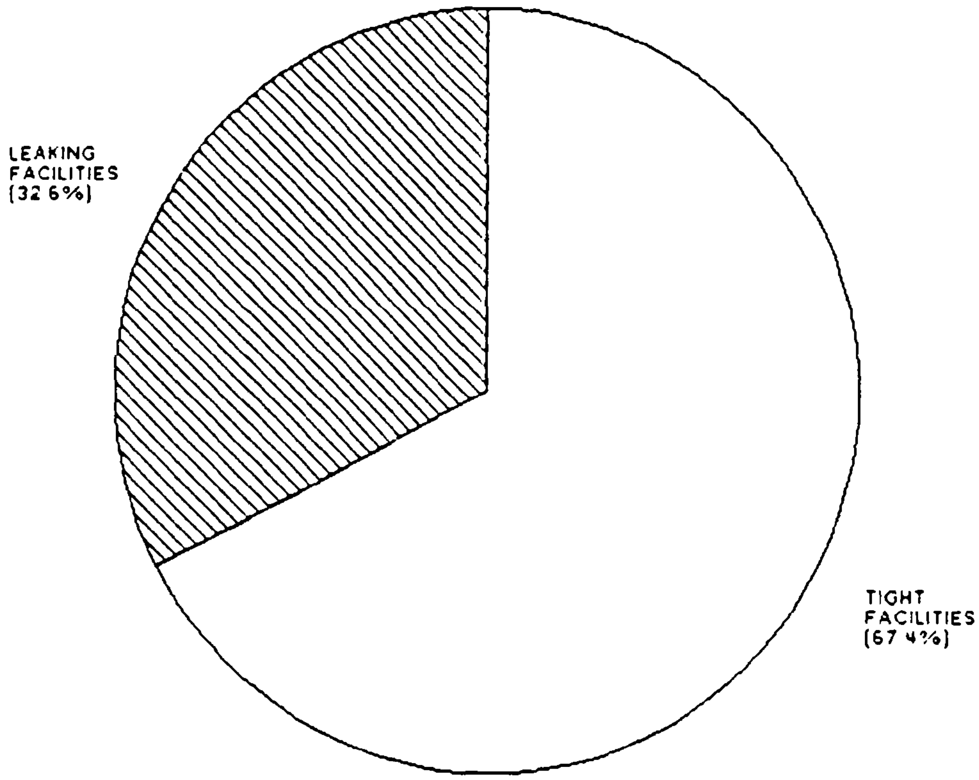


Source: SCI Estimates using UST Model results.

Exhibit 3.14

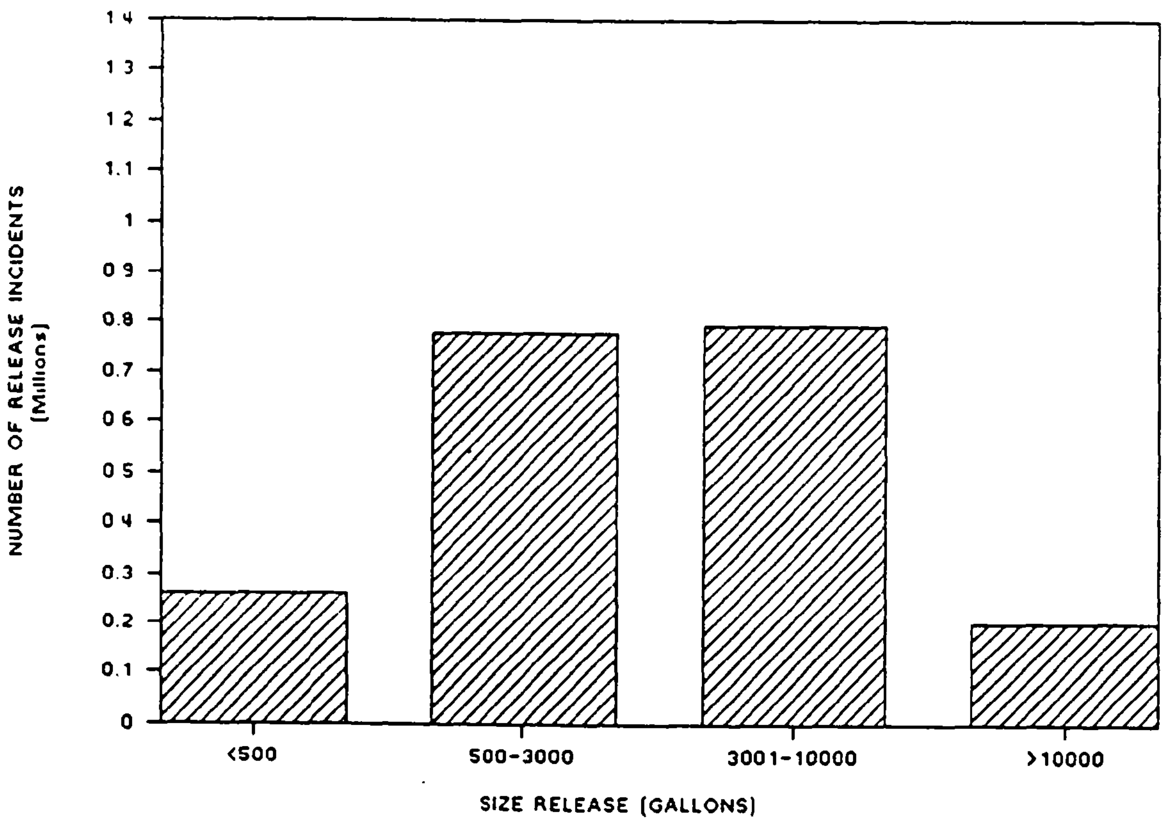
CURRENT STATUS OF UST POPULATION

BASE DETECTION: 10%-10%-4%



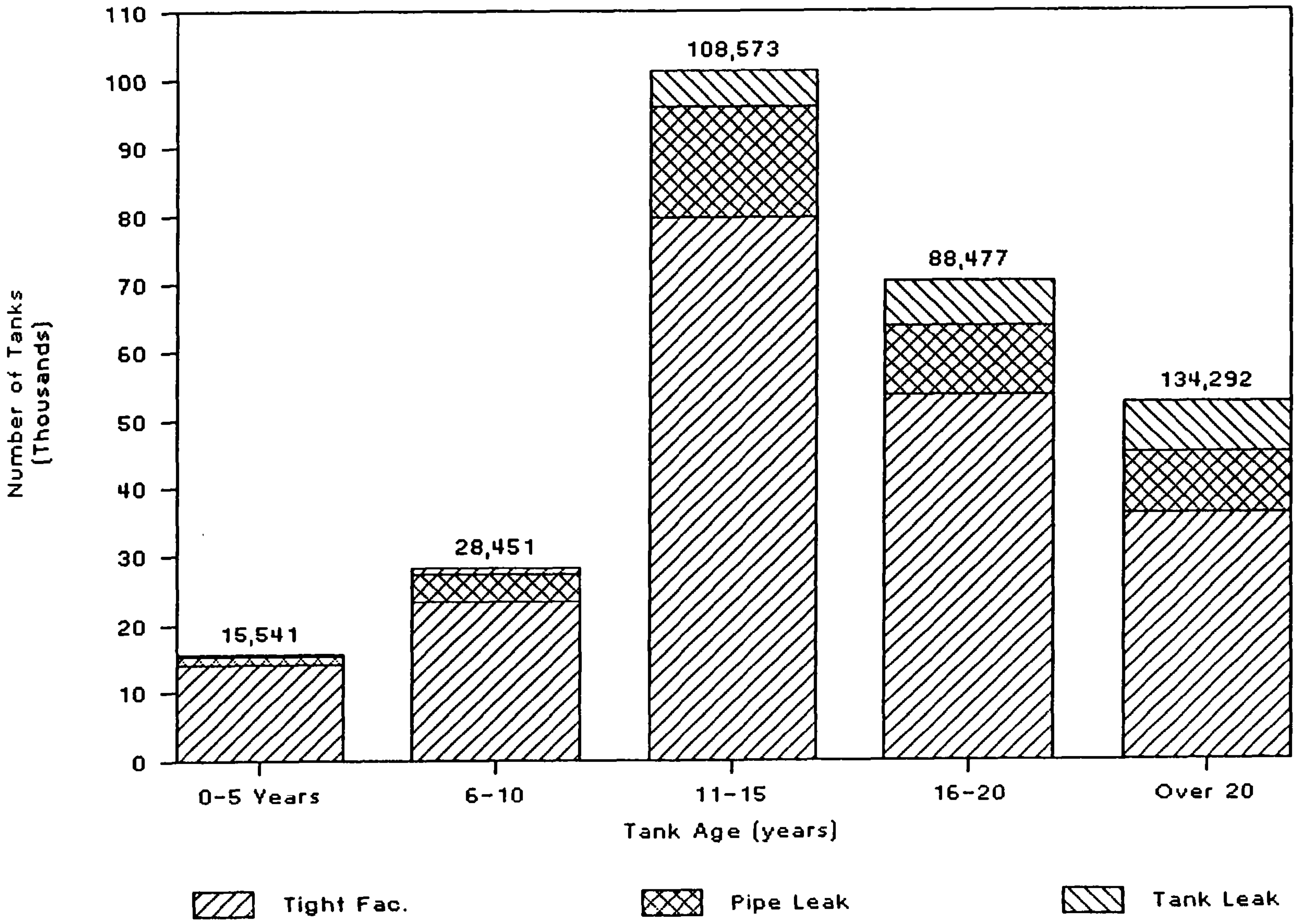
SIZE DISTRIBUTION OF RELEASE INCIDENTS

BASE DETECTION: 10%-10%-4%



Source: SCI Estimates using UST Model results.

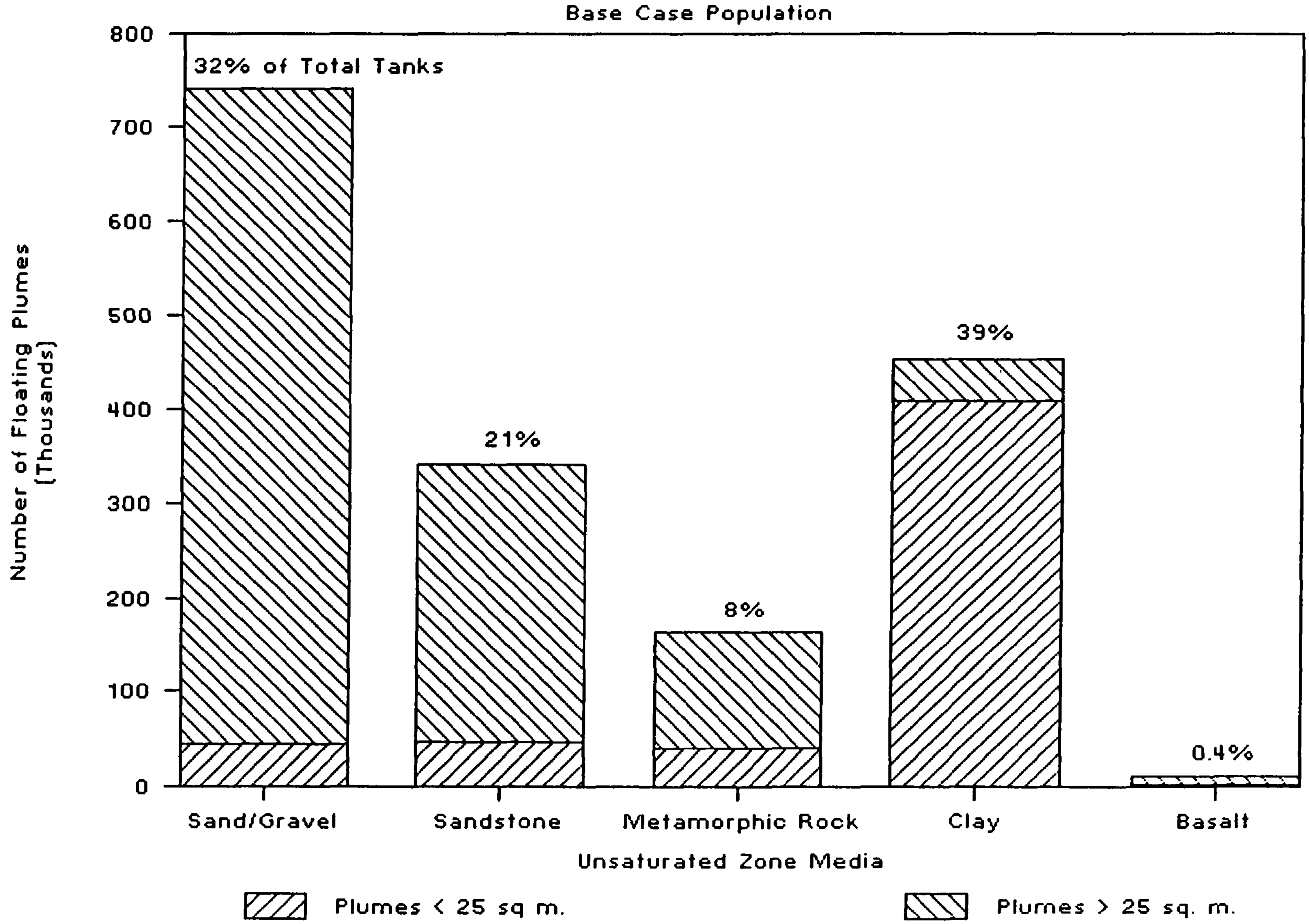
BASE CASE POPULATION BY STATUS AND AGE



Source: DRI Age Distribution; SCI and PRA Status Estimates Using UST Model

Exhibit 3.15

NUMBER OF FLOATING PLUMES BY UNSATURATED ZONE MEDIA



Source: SCI and PRA Estimates Using UST Model

Exhibit 3.16

3.G.4. Effect of Hydrogeological Setting and Resulting Plume Areas

The UST Simulation Model also allows us to analyze the effect that different parameters or external variables may have on the costs and benefits of regulations. Exhibit 3.16 illustrates the effect that different hydrogeological settings have on the number of floating plumes that occur as a result of leaking USTs. This exhibit shows the estimated number of floating plumes attributed to the base case population of tanks distributed across five unsaturated zone mediums. The distribution of floating plumes was segregated into large plumes (greater than 25 square meters) and small plumes (less than 25 square meters) to greater illustrate the affect of soil types upon plume characteristics. Sand and gravel soils, which are generally more porous and more permeable than clay soils, do not restrict the downward flow of gasoline as much as clay soils and allow the product to move more rapidly and to spread out. Sand and gravel soils therefore result in more plumes and a greater proportion of large plumes. Clay is the least permeable and the least porous of the soil types shown and therefore results in the greatest proportion of small plumes. Water table depth also affects the number and size of plumes. For a given soil type, a more shallow water table will generally result in a greater number of plumes. If the water table is relatively deep, small releases and releases that are detected relatively quickly may never reach ground water; product is released only to the unsaturated zone and there are relatively fewer plumes than with shallower water depths. In Exhibit 3.16, a distribution of ground water depths was estimated based upon analysis done by Pope-Reid Associates regarding the distribution of USTs across Heath Regions (see Exhibit 3.11).

3.G.5. Base Case Responses to Leaks

The base case is established to provide a snapshot of the present situation in order to obtain estimates of the incremental costs and the incremental effectiveness of proposed regulations. In most cases, the characteristics of the base case, or the present situation, can be estimated rather easily. For some characteristics, the estimate of present practices is much more difficult, as is the case in estimating the current level of corrective action that is undertaken when USTs are determined to be leaking.

We believe some level of corrective action currently takes place. Of the reported incidents covered in EPA's Release Incident Survey, approximately fifty percent of the incident responses reported taking some type of remedial or corrective action following leak detection. A majority of these responses reported tank removal and/or tank replacement only. Eighteen percent of these incidents reported undertaking some soil excavation. Ground-water treatment techniques, such as steam stripping, were reported by less than 12% of the responses. [1]

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[1] EPA Office of Underground Storage Tanks, Summary of State Reports on Releases from Underground Storage Tanks, August 1986, Pp. 8-6 - 8-9.

Given the fact that the Release Incident Survey reports evidence of very little corrective action taking place, and given EPA's uncertainty regarding the levels of corrective action currently occuring at leaking UST sites, we chose not to include corrective action measures, beyond pipe repairs and tank replacements, in the base case for our analysis.

When we include consideration of the cost of EPA's corrective action requirements, we incorporate the cost of corrective action into the cost of the regulatory options. We also include the cost of corrective action due to EPA's requirements that would result for the base case if current practices continued. Whenever corrective action costs are incorporated into the base case, it is appropriately labeled to avoid any confusion. In all other instances, the base case includes no corrective action measures beyond pipe repairs and tank replacements.

3.G.6. Model Results for Base Case

Table 3.1 lists the UST Model outputs for the base case population of tanks. The release volume, number of plumes and the floating plume area are the totals for all tanks in the base case (1.4 million tanks) over a thirty-year period. Total cost includes the cost of tank repairs, replacements and upgrades, and the cost of product lost due to tank system failures. Costs are shown for a period of thirty years and are discounted using a discount rate of three percent. [1]/ The base case estimates provide a picture of what could result under the alternative of no regulation. By comparing similar results of model runs simulating the imposition of each of the regulatory alternatives with the base case estimates, we can obtain estimates of incremental costs and benefits of each alternative. Using the model in a similar fashion, we can also compare the relative costs and benefits between the alternative regulatory approaches.

Exhibit 3.17 provides an estimate of the cumulative contamination from floating plumes for the base case population of tanks over a thirty-year period. After thirty years, the cumulative plume area begins to level off. Contamination is measured in acres of floating plume and does not include dispersed plume contamination to the aquifer. Again, these same results can be simulated for a tank population under each regulatory alternative and compared to the base case results to obtain estimates of incremental benefits of regulating underground storage tanks.

The following chapter, Chapter 4, introduces a range of actions that must be addressed by federal regulations to mitigate the problems of leaking USTs. Chapter 5 provides the results of cost and effectiveness analyses of UST regulatory alternatives. Chapter 5 compares the cost and effectiveness of EPA's proposed regulatory alternative to the base case and to other selected regulatory alternatives.

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[1]/ A thirty year period is used in order to provide estimates of tank failure probabilities and costs over an extended tank life. The average age of a bare steel tank is approximately 17 years, but many tanks survive for 20 or more years. A 3% discount rate is used to reflect the current real rate of interest.

TABLE 3.1

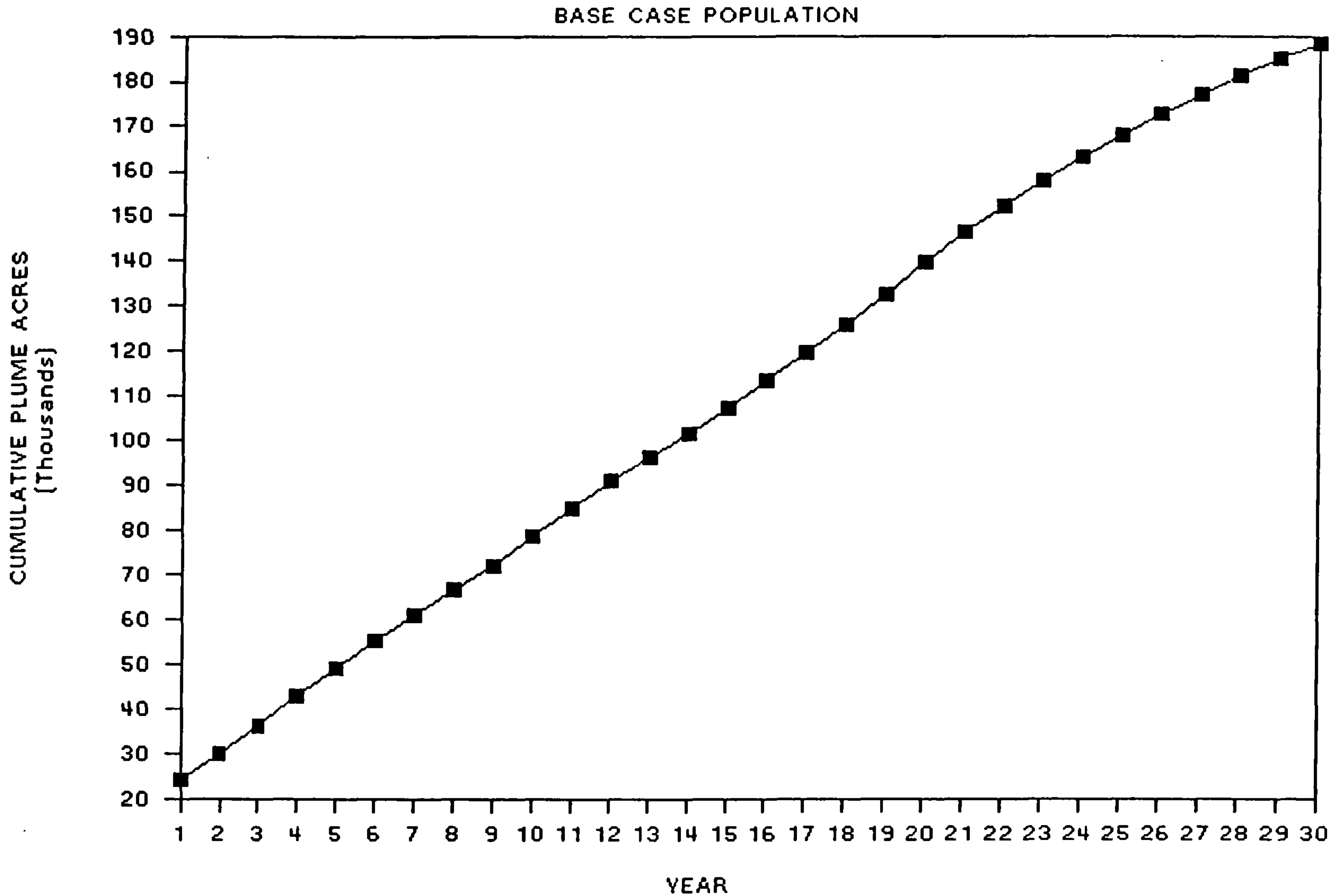
MODEL RESULTS FOR BASE CASE TANK POPULATION

(1.4 Million Tanks Over a Period of 30 Years)

Number of Release Incidents	2,667,660
Number of Floating Plumes	1,975,380
Number of Floating Plumes less than 25 square meters	537,520
Total Plume Area (Acres)	190,387
Total Cost 1/	$ 31.0 Billion

1/ Cost for 30 years discounted at 3%. Total Cost includes the cost of tank repairs, replacements and upgrades, and the cost of product lost due to tank system failures. Total cost does not include any cost for corrective action (we assume no corrective action in the base case).

CUMULATIVE FLOATING PLUME ACRES OVER A 30 YEAR PERIOD



Source: SCI and PRA Estimate Using UST Model

Exhibit 3.17

Chapter 4

COMPONENTS OF A REGULATORY STRATEGY

This chapter introduces the broad range of individual actions that could be required by the regulation to address the problem of leaking USTs. We present data on the costs of each, as used in the calculation of cost-effectiveness, and present some illustrative UST Model results on the effectiveness of each in avoiding failures, release incidents and volumes, and contaminant plumes.

4.A. INTRODUCTION

Numerous strategies and combinations of strategies could be used to mitigate the damages likely to occur in the base case. Generally, these strategies can be divided into actions that address (through corrective action) releases that occur in order to reduce the damages they may cause; actions that prevent or minimize potential releases from new tanks; actions that prevent or minimize potential releases from existing tanks; and regulations that ensure that those responsible for releases will be financially able to deal with them. The following sections take up each of these divisions, and introduce a number of component actions which could be used to make up a regulatory strategy within each division.

Some UST Model results are presented to indicate the relative costs and levels of performance of the components. A meaningful comparison of the overall cost and effectiveness of isolated, individual components of a regulatory strategy is difficult to make, however, because of the many potential interactions among the components. For instance, the relative advantages of one type of leak detection for existing tanks over another type will vary depending on the other leak detection methods used in conjunction with that type of leak detection, and on the provisions for new tanks and for corrective action. For this reason, an overall comparison of cost and effectiveness is postponed until the following chapter. That chapter describes the group of integrated regulatory options, each composed of a combination of these components, that EPA constructed as potential regulatory packages.

4.B. ALTERNATIVE ELEMENTS OF A STRATEGY FOR NEW TANKS

The principle choices to be made for regulations of new USTs involve the construction of the tank (which determines the frequency of failure and/or release) and the method and frequency of leak detection (which affects the eventual size and longevity of any release that occurs). The main alternatives for each of these areas are described in the following sections. A number of other choices, for instance, those involving regulation of installation practices, although important, are basically secondary and are not discussed explicitly here.

4.B.1. Tank Construction

A basic choice in the regulation of new tanks is the specification of the construction of the tanks. Protection against corrosion (the main cause of releases from existing systems) and provision for containment of releases from the system are the most important goals for tank construction standards.

Choices for materials for tank construction include bare steel, steel that is coated to help protect against corrosive conditions, cathodically protected steel (protected either by sacrificial anodes or impressed current, and generally given an insulating coating as well), and non-corroding fiberglass. The Interim Prohibition (HSWA §9003(g)) allows bare steel tanks only in selected settings where corrosion is considered to be a less serious problem. Thus, the question of requiring corrosion protection or not in the new tank regulations is largely moot because of this statutory mandate.

4.B.1.a Effectiveness in Reducing Failures

Exhibit 4.1 displays the frequency of failures over a thirty-year life as predicted by the UST Model for three systems: bare steel tank and piping; coated and cathodically protected steel tank and piping; and fiberglass tank with cathodically protected steel pipes.

4.B.1.b. Costs of Corrosion-Resistant Systems

The capital cost of corrosion protection is not trivial, but it is nonetheless relatively small compared to the total costs of purchasing and installing a new tank. In addition, once the life-cycle savings in reduced repair and replacement costs are factored in, corrosion-resistance can pay for itself. Exhibit 4.2 shows the approximate purchase and installation costs, repair and replacement costs, and costs associated with testing and maintaining the cathodic protection systems. Costs other than the purchase and installation costs are discounted at 3 percent per annum. Not included are costs of lost product or corrective action costs; inclusion of these costs would work in favor of the protected tanks compared to the bare steel tanks.

4.B.1.c Comparisons of the Cost and Effectiveness of Bare Steel and Protected Tanks

The data from the previous exhibits is presented in the form of a two-way plot in Exhibit 4.3. The costs of the systems (broken into first costs and other costs) are measured on the vertical axis, while the effectiveness of the systems in terms of preventing the releases allowed by a bare-steel system is measured on the horizontal axis. Presented in this way, the data allow us to compare the alternatives over two dimensions simultaneously. Preferred systems are those falling further toward the lower right--those higher in effectiveness and at the same time lower in cost. If any system is below and to the right of all other systems, it is said to dominate the others. If two systems are found at the same distance along the effectiveness axis, then the one with the lower cost is said to be more cost-effective than the other. If a comparison of two systems shows one to be above and to the right of the other--more costly and more effective--then the incremental cost per unit of effectiveness may be measured by comparing the vertical difference between the two to the horizontal difference. This framework is used repeatedly in the analysis that follows to allow elements of the options, and the options themselves, to be compared.

Exhibit 4.1

FAILURE FREQUENCIES BY TANK SYSTEM TYPE

SYSTEM TYPE	FAILURES PER SYSTEM PER 30 YEARS	% REDUCTION VS. BARE STEEL
BARE STEEL TANK AND PIPING	3.81	NA
COATED & CATHODICALLY PROTECTED TANK AND PIPING	0.65	83%
FIBERGLASS TANK, PROTECTED PIPING	0.54	86%

Exhibit 4.2

TOTAL PRESENT VALUE COSTS BY TANK SYSTEM TYPE
(4,000 gallon tanks)

SYSTEM TYPE	PURCHASE AND INSTALLATION	REPAIR AND REPLACEMENT	CATHODIC PROTECTION MAINTAINENCE	TOTAL COST
BARE STEEL TANK AND PIPING	$ 19,995	$ 8,076	NA	$28,071
COATED & CATHODICALLY PROTECTED TANK AND PIPING	$ 21,100	$ 544	$392	$22,036
FIBERGLASS TANK, PROTECTED PIPING	$ 26,825	$ 701	$392	$27,918

Note: Present values calculated assuming a 30-year life and 3% discount rate. Estimated costs are per tank, assuming a 3-tank facility. They do not include costs of product lost to releases, or the estimated salvage value of the systems at the end of the 30-year period.

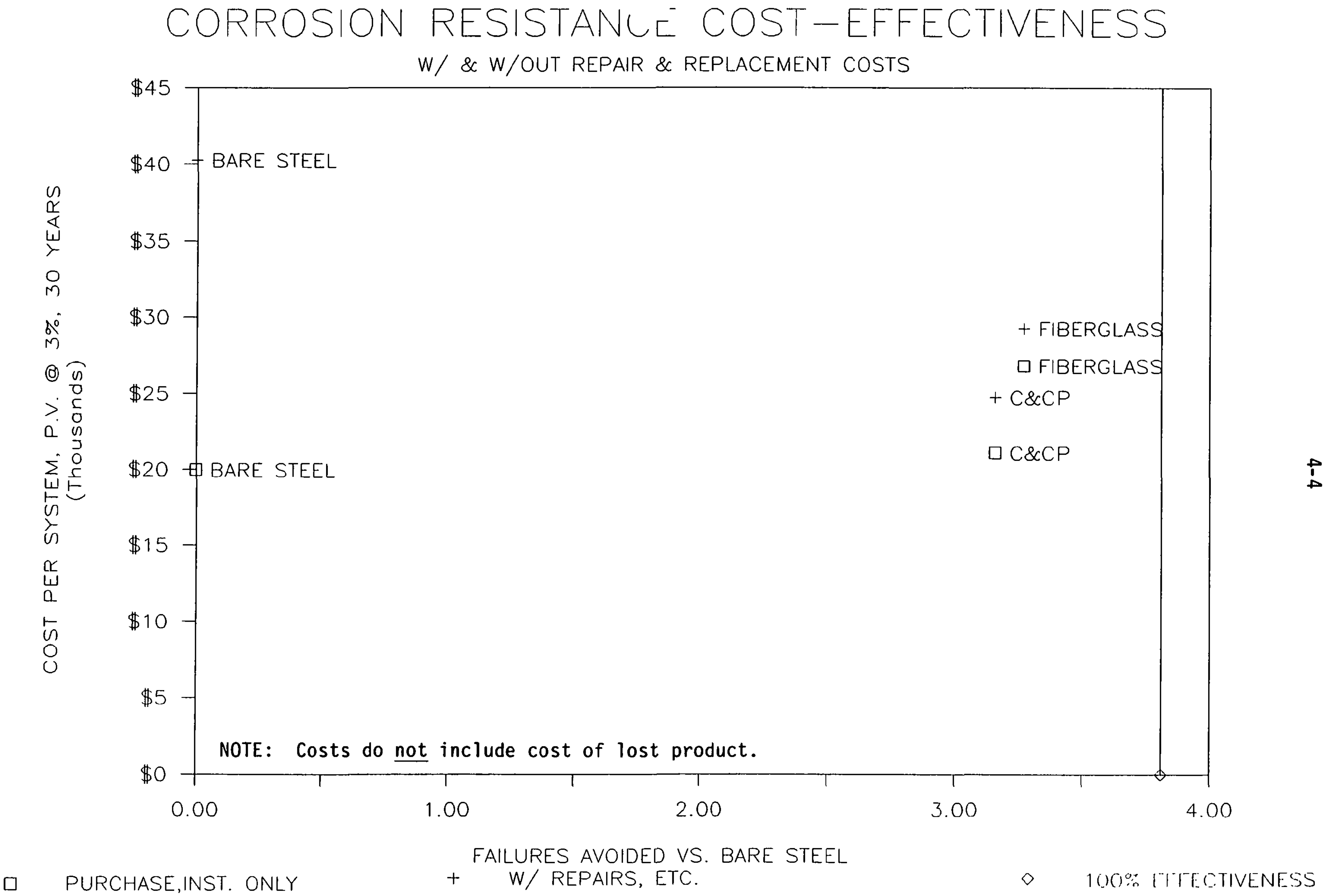

CORROSION RESISTANCE COST-EFFECTIVENESS
W/ & W/OUT REPAIR & REPLACEMENT COSTS
COST PER SYSTEM, P.V. @ 3%, 30 YEARS
(Thousands)
$45
$40
$35
$30
$25
$20
$15
$10
$5
$0
BARE STEEL
BARE STEEL
FIBERGLASS
FIBERGLASS
C&CP
C&CP
NOTE: Costs do not include cost of lost product.
0.00
1.00
2.00
3.00
4.00
FAILURES AVOIDED VS. BARE STEEL
PURCHASE,INST. ONLY
W/ REPAIRS, ETC.
100% EFFECTIVENESS

Exhibit 4.3

The exhibit shows that, not counting repair and replacement, the bare-steel system is the cheapest and least effective. The fiberglass system is the most costly and, by a slight margin, the most effective. Counting repairs and replacements, discounted moderately, the corrosion-resistant tanks both dominate the bare-steel system. The cathodically protected steel tank is somewhat less costly than the fiberglass tank, but appears slightly less effective.

4.B.1.d. Costs and Effectiveness of Tank Systems Constructed to Intercept Releases

Even corrosion-resistant tank systems are subject to releases. Containment of these releases before they can enter the environment can be accomplished either through the use of impermeable liners under the tank and piping or with a second wall for the tanks and/or pipes. Due to the added cost of these systems, they would almost certainly be specified as corrosion-resistant, if only to protect the additional investment. It is natural to combine secondary containment systems with a leak detection system able to identify a breach in one wall before the second wall (or liner) fails or is overwhelmed by the release. Total costs for these systems are presented alongside the costs for other tank systems and the frequency of releases to the environment in Exhibit 4.4. The costs shown in this exhibit include costs of lost product, but not the salvage value of the systems at the end of the period of the analysis. These data are displayed graphically in Exhibit 4.5.

4.B.1.e. Marginal Cost Effectiveness of Tank Construction Alternatives

The data presented in Exhibits 4.4 and 4.5 can be used to examine the marginal cost effectiveness of release prevention through tank system design. Single-wall, cathodically protected steel tanks dominate both unprotected steel tanks and fiberglass tanks, showing lower total costs and fewer release incidents. For this reason, it makes little sense to discuss the marginal cost of reducing releases through the use of a single-wall cathodically protected system. We can calculate, though, that moving from a single-wall protected system to a protected system with a liner will cost about $7,500 more per tank and will prevent about 0.4 releases over thirty years. Thus, the incremental cost per release avoided would be about $18,500. (The incremental cost of secondary containment is higher for the larger tanks which are typically used as replacement tanks. Releases avoided by secondary containment would be smaller if a shorter average time horizon were used for the analysis, as is appropriate for replacement tanks which will not be installed immediately but only as existing tanks fail. These differences between the analysis presented here, for new tanks, and the analysis in Chapter 5, for replacement tanks, explains why liners appear much more cost-effective in this section than in Chapter 5.) Whether this cost is worth incurring will depend on the seriousness of the avoided releases, whether they would have to be cleaned up and to what degree, what the cleanups would cost, and for how many years and at what rate the costs would be discounted. For instance, if releases typically required $100,000 in cleanup expenditures (or, in the absence of cleanup, would do $100,000 or more in damage), then the cost of the lined system would be well worth paying.

4.B.1.f. Influences on the Value of Avoiding Releases

The damage done by a typical release depends in large part on the volume of the release and the duration over which it is allowed to continue before it is detected. If a device or system is used with a single-wall tank system that is

Exhibit 4.4

COSTS AND RELEASE FREQUENCIES BY TANK SYSTEM TYPE

SYSTEM TYPE	TOTAL COST PER TANK, 3 TANK FACILITY	NUMBER OF RELEASES TO THE ENVIRONMENT PER TANK, OVER 30 YEARS
BARE STEEL TANK AND PIPING	$ 42,602	3.36
COATED & CATHODICALLY PROTECTED TANK AND PIPING	$ 25,130	0.60
FIBERGLASS TANK, PROTECTED PIPING	$ 29,825	0.50
LINER WITH INTERSTITIAL MONITOR	$ 32,515	0.20
DOUBLE WALL TANK AND PIPES	$ 34,152	0.25

Note: Costs are the present value of all capital and operating costs for 30 years, discounted at 3 percent per year. They include costs of lost product, but do not include a credit for the salvage value of systems remaining at the end of the 30-year period.

COST-EFFECTIVENESS BY SYSTEM TYPE

IN AVOIDED RELEASES TO THE ENVIRONMENT

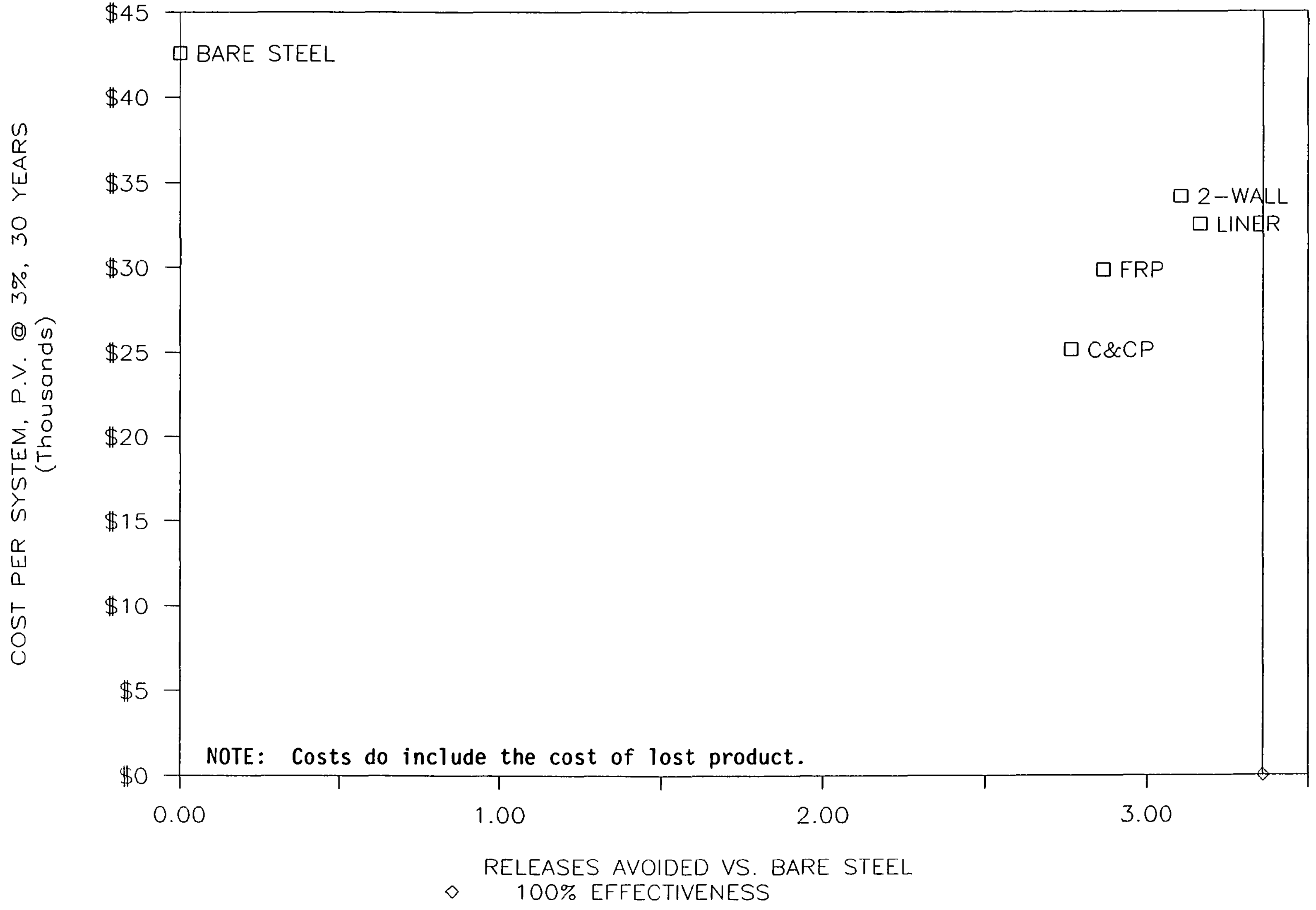


Exhibit 4.5

capable of detecting releases promptly, many releases can be stopped before they have contaminated the ground water. This alone greatly reduces the damage that can be done by the release, as well as the costs of cleaning it up. Even if a release cannot be detected before it forms a plume on the ground water, more rapid detection can reduce health risks dramatically by keeping concentrations of contaminants in the ground water low and by reducing the time of exposure. The next section turns to the alternatives available for the detection of leaks.

4.B.2. Alternative Systems for Leak Detection

Numerous systems have been developed to allow detection of leaks or releases from underground tank systems, and still more have been proposed. In this section, a partial list of systems that might be used is presented and described briefly in terms of method of operation, cost, and effectiveness in minimizing ground-water contamination. Given the choice of a method of detection, there will often be further choices of the sensitivity of the sensors used and of the frequency with which the method is used. Systems addressed include:

- Tank and pipe tightness tests;
- Line leak detectors;
- Vapor wells;
- Floating liquid sensors or observation wells;
- Manually-operated inventory monitoring programs;
- Automatic inventory control; and
- Interstitial space monitor (for secondary containment systems).

Each is discussed below.

4.B.2.a. Operation, Advantages, and Disadvantages of Detection Methods

Tank and Pipe Tightness Tests

Various methods are used to determine whether a tank system is tight or not. Commonly, a tank will be taken out of service for a number of hours, filled to capacity, allowed to reach equilibrium in temperature and shape, and then monitored accurately to detect any drop in the level of liquid. (Variations include applying a partial vacuum and listening for bubbles, or filling with an inert gas and using vapor sensors outside the tank.) Advantages: Can detect slow (0.15 gallon per hour) leaks with a relatively high degree of certainty. Disadvantages: Too costly (at about $500 per test) and disruptive to perform except at infrequent intervals (perhaps no more than once a year); some small but still significant leaks can escape detection; inconsistent if testers have not had adequate training; might indicate a leak when the only gap in the system is a loose fitting at the top of the tank which would not release product under actual operating conditions.

Line Leak Detectors

Line leak detectors are designed to signal piping failures by identifying an abnormal pressure drop in pressurized delivery lines. Advantages: Operates continuously; some are low in price; some are able to detect relatively slow leaks; automatic in operation and therefore less dependent on skillful operators to be effective. Disadvantages: Low priced devices are relatively insensitive and may be subject to wear, and sensitive devices are relatively expensive. They can miss some significant leaks, and are applicable only to pressure

Vapor Wells

This detection system consists of an array of wells around the tanks equipped with continuously operating sensors to detect the vapors which are generated by released product and which diffuse through the vadose zone (unsaturated material above the water table). Alternatively, samples can be drawn periodically from the wells and tested for traces of product vapors. Advantages: Can trigger an alarm soon after product is released; relatively inexpensive to install and operate, given the level of protection it can provide; may be able to detect very slow leaks. Disadvantages: May be unreliable due to unpredictable patterns of vapor movement; may not indicate which tank is leaking; might be subject to false alarms, especially if releases occured at the site in past years; solid data on performance in real-world applications is not yet available; may not work in some settings (fractured rock, high water table).

Floating Liquid Sensors or Observation Wells

These are similar in some ways to vapor monitors, but rely on finding actual product in wells (using automatic sensors or periodic sampling) instead of vapors. Advantages: Able to detect some very slow leaks; allow identification of which tank is leaking; little danger of false alarm. Disadvantages: Might miss some leaks all together; might detect a release only after a long time lag; floating sensors by definition are unable to detect a release until it has already contaminated some ground water, although an observation well with sensors above the ground water table could detect some releases before they reached the ground water.

Manually-Operated Inventory Monitoring Programs

Over time, records of product levels in tanks, deliveries, and sales generate data which can be analyzed statistically to detect a pattern of disappearing product. Advantages: Low in cost, given that the data should be collected for accounting purposes and to detect theft in any case; potentially able to detect fairly slow leaks; designed to be used frequently enough to detect many leaks before much damage is done. Disadvantages: Requires training and some skill to use effectively; will miss some small but significant leaks, and will detect others only after a time lag.

Automatic Inventory Monitoring and Control

These systems automate the inventory tracking procedures described above, employing a set of sensors in the tanks connected to a central control box. Advantage: Eliminates the need for training, skill, and diligence in measuring and recording product levels. Disadvantages: Somewhat expensive (though they reduce the burden on the persons who would otherwise have had to make, record and analyze stick readings) and are untested for detecting slow leaks.

Interstitial Monitors

These devices use a variety of means (most notably pressure change or conductivity sensors) to detect the presence of product in the interstitial space (between the inner and outer containment barriers) in secondary containment systems. Advantages: Very rapid and reliable detection. Their superior performance is due not to their own special characteristics, but to the controlled environment between the inner and outer walls. The space between the walls of a double-wall tank can be made air-tight, so that any hole in either wall can be quickly detected by a change in pressure or a change in the level of a liquid filler. Alternatively, the outer wall (or the liner in a lined system) will channel any product released from the inner wall towards a sensor at the lowest point in the system, while simultaneously simplifying detection by keeping ground water out of the system. Disadvantage: Can be used only in conjunction with secondary containment, which is expensive.

4.B.2.b. Costs and Effectiveness for Leak Detection Methods

Costs for various systems of leak detection are presented in Exhibit 4.6. The costs are built up from the initial costs, and the detection method's per-use costs (i.e.: one tightness test is $520) multiplied by frequency of use to yield annual costs. These are combined to give a present discounted cost of leak detection for a thirty-year period. Automatic inventory control systems have not been included because of the difficulty of predicting their level of sensitivity.

The effectiveness of the different systems is difficult to predict, as it is influenced both by the pattern of leaks expected and chance factors (such as the behavior of vapors in the complex physico-chemical environment which exists underground) on which little information is available. We have used the UST Model, and a set of assumptions about the reliability of the methods, to illustrate the relative abilities of the systems to reduce release volumes from one particular type of tank in one type of aquifer over a thirty-year period. The results of this limited analysis are presented in Exhibit 4.7.

The information from the previous exhibits can be combined to show the cost-effectiveness of the detection methods, in terms of release volumes and plume areas avoided. This comparison is depicted in Exhibit 4.8. The exhibit shows that the costs of monthly vapor monitoring (VW-M), yearly tightness testing (TT-1/YR), and especially manual inventory control (MAN. INV.) are out of proportion to their effectiveness. These are the three systems with high continuing costs. By contrast, vapor wells with a continuous sensor (VW-C) which have high initial costs but have little or no annual costs, are shown to dominate the other options, as they are the most effective and the least costly systems.

4.C. ALTERNATIVES FOR EXISTING TANKS

In some ways, the alternative actions for reducing releases from existing tanks are more limited than for new tanks, since no choice of tank type can be made and because some detection methods are impractical to retrofit. The choice of actions is, however, still quite broad. Many alternatives exist for systems to allow early detection of releases; it appears to be possible to add effective corrosion protection to existing bare steel tanks; and the option of requiring early retirement of tanks and replacement with new tanks is available.

4.C.1. Mandatory Retirement

Forcing early retirement of existing tanks, thereby making way for the installation of new tank systems less prone to corrosion and undetected releases, is obviously one effective response to the problem of existing tanks. Its

Exhibit 4.6

COSTS OF LEAK DETECTION METHODS
(Per Tank, for New 3-Tank Facilities)

SYSTEM	INITIAL COST	COST PER YEAR	PRESENT VALUE OF COST, 30 YRS
MANUAL INVENTORY	$ 0	$730	$14,308
TIGHTNESS TEST (ANNUAL)	0	520	10,192
TIGHTNESS TEST (3 YEAR)	0	173	3,397
FLOATING SENSOR (SAMPLED MONTHLY)	180	33	833
VAPOR SENSOR (SAMPLED QUARTERLY)	180	100 †	2,140
VAPOR SENSOR (SAMPLED MONTHLY)	180	300 †	6,060
VAPOR SENSOR (CONTINUOUS)	1753	0	1,753
LINE LEAK DETECTOR (LOW COST)	350	0	350
LINE LEAK DETECTOR (IMPROVED)	1585	0	1,585

† The annual operating cost for vapor wells represents a cost of a quarterly or monthly visit to the site by an outside contractor (lab) to check the well sensor at a cost of $25 a visit. The annual operating cost may be lower if the station operator elects to check the well sensor himself; however, the level of effectiveness may than deteriorate.

Exhibit 4.7

EFFECTIVENESS OF DETECTION METHODS IN REDUCING RELEASE VOLUMES AND FLOATING PLUME AREAS OVER 30 YEARS

SYSTEM	% REDUCTION OF RELEASE VS. BASE DETECTION	% REDUCTION OF PLUME AREA VS. BASE DETECTION
BASE DETECTION ONLY	NA	NA
MANUAL INVENTORY	8.9 %	8.9 %
TIGHTNESS TEST (ANNUAL)	46.4	59.6
TIGHTNESS TEST (3 YEAR)	31.3	44.0
FLOATING SENSOR (MONTHLY)	41.3	56.5
VAPOR SENSOR (QUARTERLY)	63.2	76.5
VAPOR SENSOR (MONTHLY)	65.0	76.7
VAPOR SENSOR (CONTINUOUS)	65.2	76.8
LINE LEAK DETECTOR (LOW COST) *	31.3 (0.0 vs. 3 yr TT)	44.0 (0 vs. TT)
LINE LEAK DETECTOR (IMPROVED) *	39.0 (7.7 vs. 3 yr TT)	45.6 (1.6 vs. TT)

* Line leak detectors were run along with three year tightness tests; the release and plume area reductions shown are the additional reductions in the percentage of base detection releases and plumes attributable to the line leak detectors.

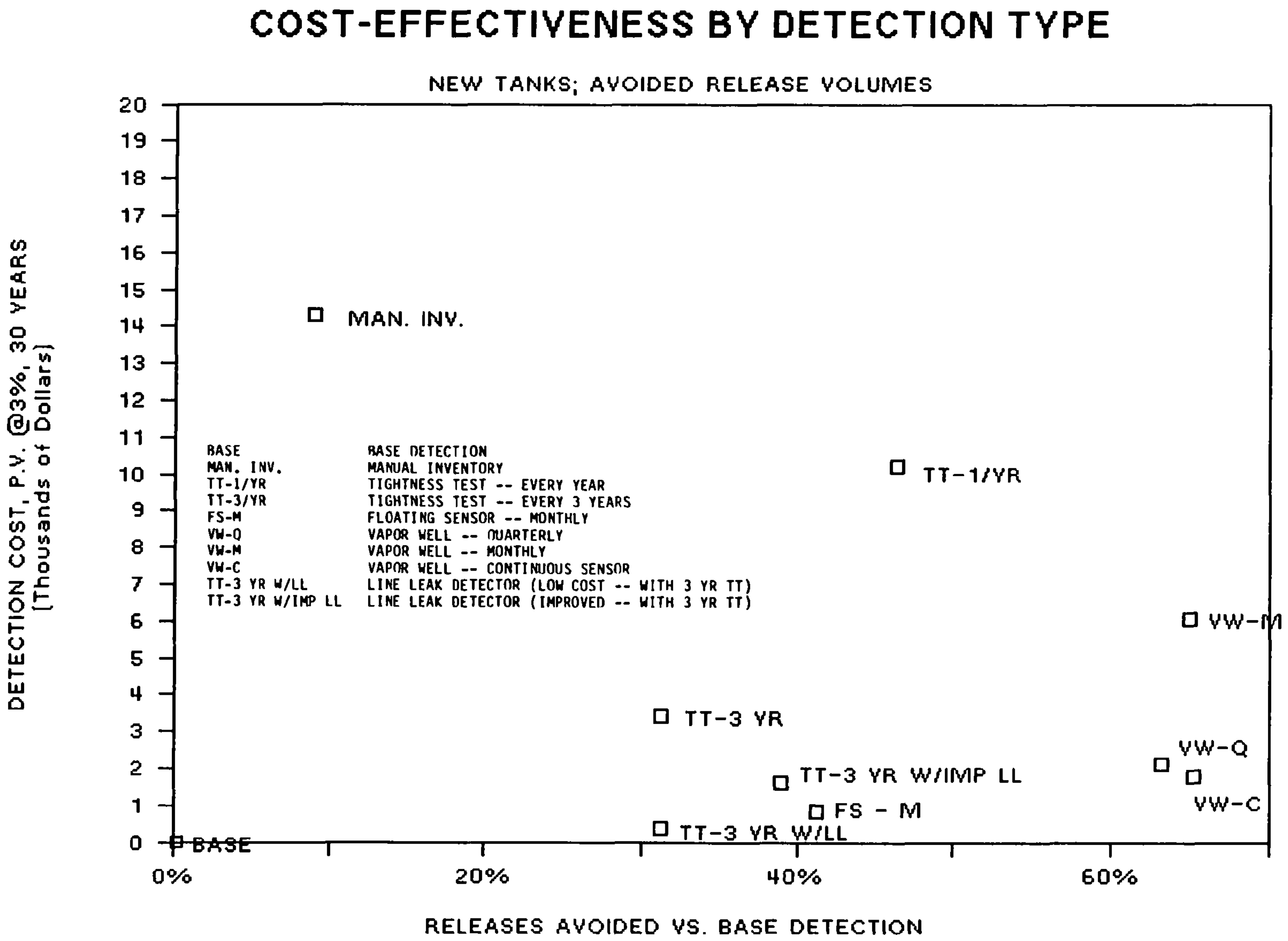

COST-EFFECTIVENESS BY DETECTION TYPE
NEW TANKS; AVOIDED RELEASE VOLUMES
DETECTION COST, P.V. @3%, 30 YEARS
(Thousands of Dollars)
RELEASES AVOIDED VS. BASE DETECTION
0%
20%
40%
60%
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
BASE
MAN. INV.
TT-1/YR
TT-3 YR
TT-3 YR W/IMP LL
FS - M
TT-3 YR W/LL
VW-M
VW-Q
VW-C
BASE BASE DETECTION
MAN. INV. MANUAL INVENTORY
TT-1/YR TIGHTNESS TEST -- EVERY YEAR
TT-3/YR TIGHTNESS TEST -- EVERY 3 YEARS
FS-M FLOATING SENSOR -- MONTHLY
VW-Q VAPOR WELL -- QUARTERLY
VW-M VAPOR WELL -- MONTHLY
VW-C VAPOR WELL -- CONTINUOUS SENSOR
TT-3 YR W/LL LINE LEAK DETECTOR (LOW COST -- WITH 3 YR TT)
TT-3 YR W/IMP LL LINE LEAK DETECTOR (IMPROVED -- WITH 3 YR TT)

Exhibit 4.8

advantages are clear: because new, protected tanks are likely to have dramatically lower releases than the old and inferior tanks they replace, wholesale replacement of tanks could almost eliminate future damages from USTs. This is illustrated in Exhibit 4.9, which shows cumulative plume areas over time with and without a policy of mandatory retirement five years after the promulgation of the UST regulations.

The disadvantages of this alternative are that it would be very costly, and might be hard to implement without causing capacity problems in tank manufacturing and installation.

To judge the ultimate cost and effectiveness of many potential alternatives, including programs of mandatory retirement, the costs and performance of new tanks must be considered along with the cost and performance of the choices made for the existing tanks. This issue is dealt with in Chapter 5, which takes up the question of comparisons among comprehensive, integrated regulatory options.

4.C.2. Tank Upgrades

Upgrading of existing bare steel tanks to offer some protection against corrosion or releases is an accepted practice. These actions for existing tanks are analogous to the choice of a method of construction for new tanks, since they are aimed at release prevention. We have some information about the costs of these steps, but no data on effectiveness.

- o Retrofit of Cathodic Protection
- o Interior Coating
- o Retrofit of Lining or Partial Lining of Tanks or Pipes

Exhibit 4.10 provides a summary of what is known about cost and effectiveness of these upgrade options.

4.C.3 Leak Detection

Leak detection options for existing tanks are essentially the same as for new tanks, though it is generally more expensive to add leak detection devices to existing tanks than to incorporate them into the design of a new tank system. Exhibit 4.11 presents the costs and effectiveness of several leak detection systems for existing bare steel tanks, as estimated using the UST Model. The data are presented graphically in Exhibit 4.12. Again, the vapor monitoring systems are the most attractive. Although for new tanks the continuous monitor is more advantageous than the intermittent monitors, the continuous vapor monitor is less advantageous compared to the intermittent monitors for existing tanks, largely because with an existing tank there will be fewer years of use for the system compared to a new facility.

An important side issue is the phasing in of leak detection. It will not be practical to equip all UST facilities with leak detection immediately, due to capacity problems in the industry and uncertainties about the best designs for leak detection systems. Given, then, that some facilities will be equipped with leak detection sooner than others, the question of which sites should be given priority arises. Two considerations that should influence the strategy for the phasing in of leak detection (and upgrading or early retirement as well) are the expectation of release at a given facility, and the expectation of

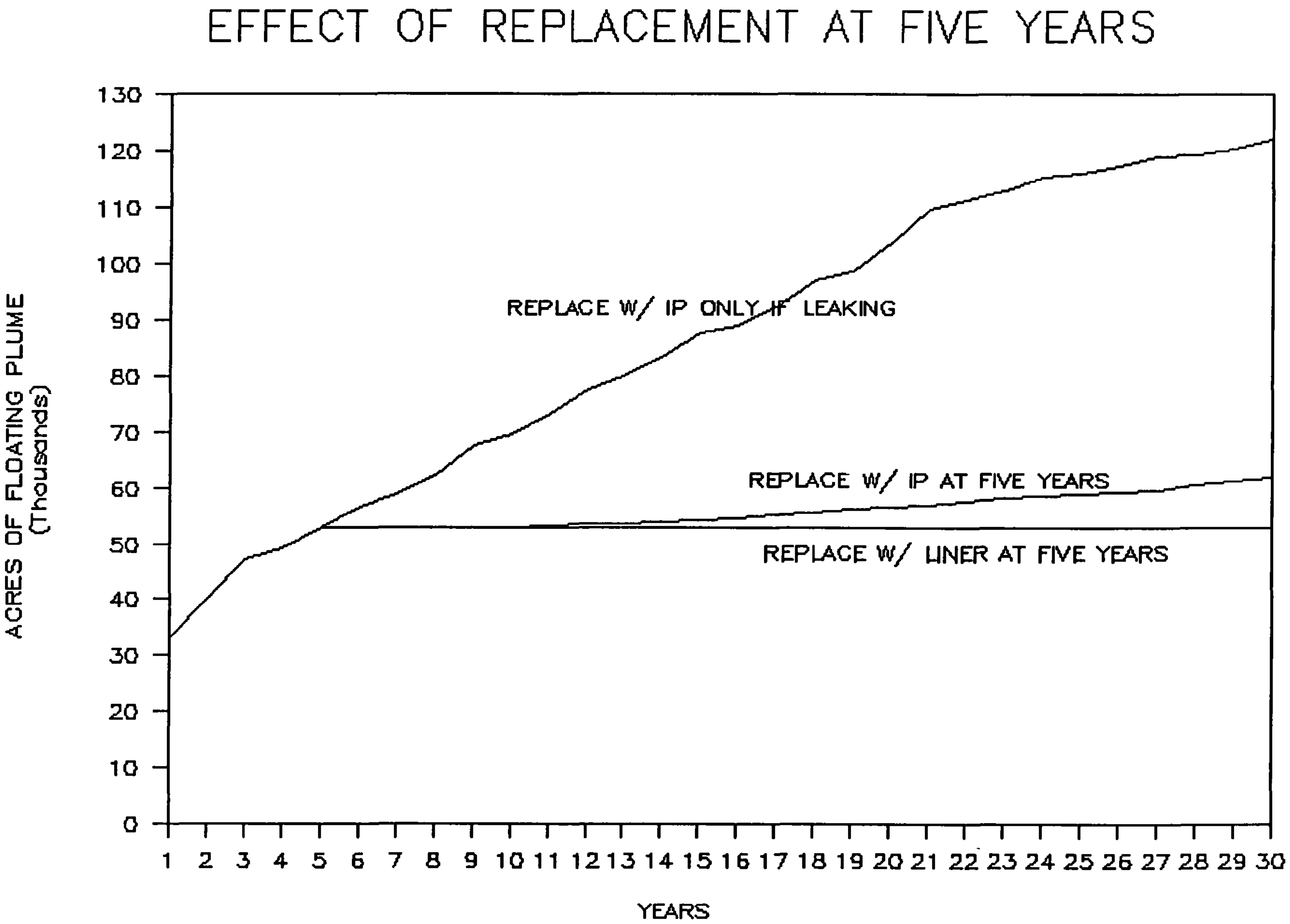

EFFECT OF REPLACEMENT AT FIVE YEARS
ACRES OF FLOATING PLUME (Thousands)
130
120
110
100
90
80
70
60
50
40
30
20
10
0
REPLACE W/ IP ONLY IF LEAKING
REPLACE W/ IP AT FIVE YEARS
REPLACE W/ LINER AT FIVE YEARS
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
YEARS

Exhibit 4.9

Exhibit 4.10

SUMMARY OF COST AND EFFECTIVENESS OF ACTIONS TO UPGRADE EXISTING TANKS
(Per Tank, for Existing 3-Tank Facilities)

OPTION	APPROXIMATE COST	LIKELY DEGREE OF EFFECTIVENESS
RETROFIT OF CATHODIC PROTECTION	$3,050	Very high
INTERIOR COATING........................	$1,420 - $4,100	High only for corrosive products
RETROFIT OF LINER AND SUMP MONITOR*.....	$12,350 - $18,450	Very high
RETROFIT OF PARTIAL LINER (BOTTOM OF EXCAVATION ZONE) AND SUMP MONITOR*...	$11,100 - $17,200	Possibly very high

* Includes $900 for sump monitor.

Exhibit 4.11

COSTS AND EFFECTIVENESS OF LEAK DETECTION METHODS
(Per Tank, for Existing 3-Tank Facilities)

SYSTEM	INITIAL COST	COST PER YEAR	PRESENT VALUE COST **	% REDUCTION OF RELEASE VOLUMES VS. BASE DETECTION
MANUAL INVENTORY	$ 0	$730	$7,570	19.9 %
TIGHTNESS TEST (ANNUAL)	0	520	5,052	56.8
TIGHTNESS TEST (3 YEAR)	0	173	1,627	34.1
FLOATING SENSOR (MONTHLY)	500	33	1,711	24.5
VAPOR SENSOR (QUARTERLY)	500	100	1,668	57.7
VAPOR SENSOR (MONTHLY)	500	300	3,630	60.4
VAPOR SENSOR (CONTINUOUS)	2073	0	2,847	63.2

** Costs shown here are the average present value costs of detection for the remaining life of an existing tank. The period of time over which the per-tank costs are discounted varies depending upon when the tank fails, or is replaced with a new tank system. In the simulation, an existing tank, on average, lasted 12 years before it failed and/or was replaced.

COST-EFFECTIVENESS BY DETECTION TYPE

EXISTING TANKS; AVOIDED RELEASE VOLUMES

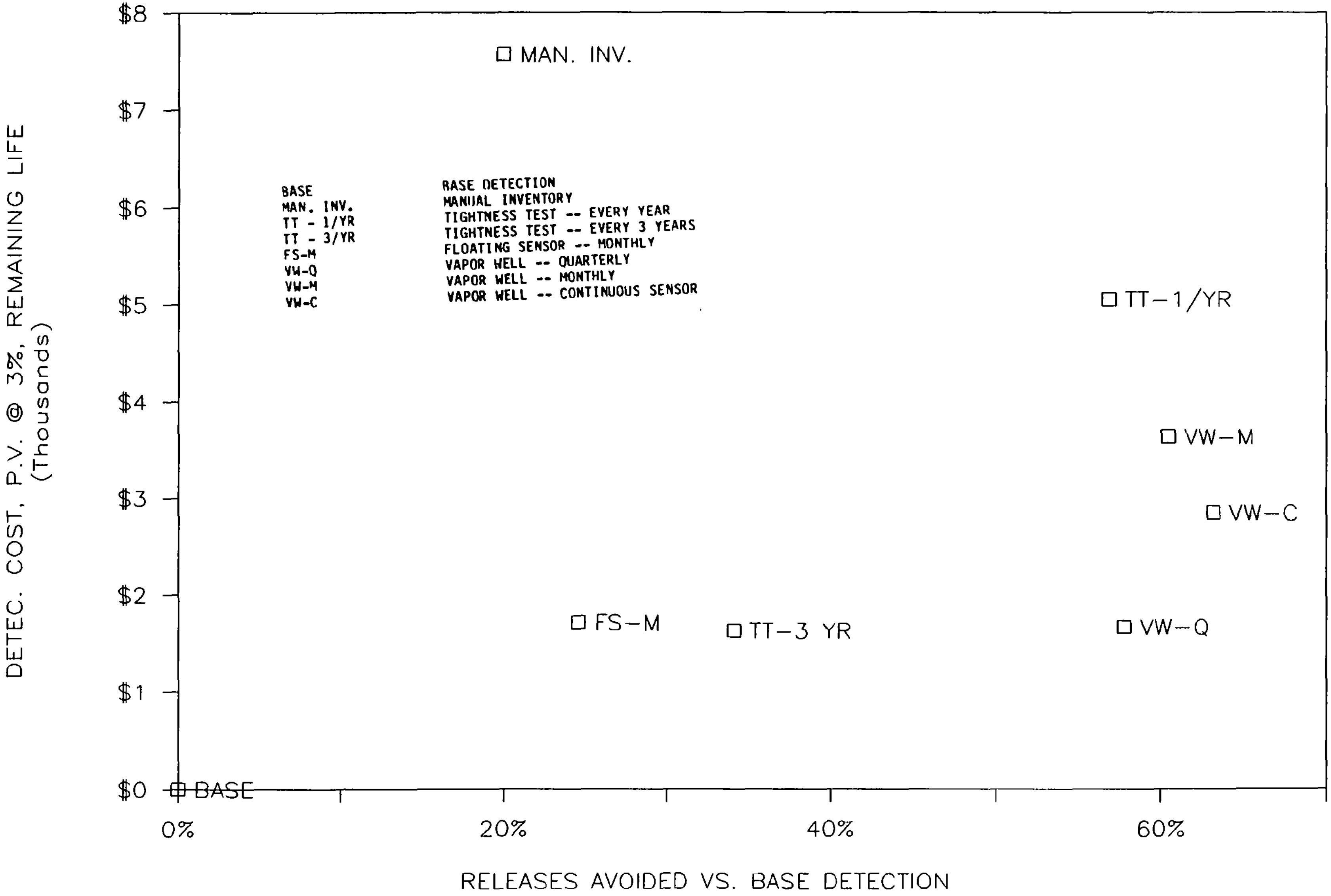


Exhibit 4.12

damages and risks if a release occurred at the facility. Older, unprotected USTs and/or USTs near drinking water sources should presumably be required to install leak detection first. A quantitative examination of the contribution that a proper phase-in strategy can make is included in Section 5.C.3.h. which discusses the sensitivity of the cost effectiveness results.

4.D. ALTERNATIVES FOR CORRECTIVE ACTION

4.D.1. Specification of Alternatives

As discussed earlier, damage can be avoided by preventing releases or by halting and cleaning them up once they have occured. Options for cleaning up the releases, referred to as corrective action, can be broken down into immediate actions to reduce the hazards associated with releases and longer-term actions to remove the portion of the release dissolved in the ground water.

Based on a consensus in the state programs on immediate actions to be taken upon discovery of a release (referred to as stage-one actions), few options are open. It is considered necessary to take certain steps, as described below.

First, once a leak is indicated or suspected, the operator must notify the state agency and then either confirm that the system is leaking or assume that it is leaking. The leak must be stopped immediately and steps must be taken to mitigate any fire or safety hazard. The operator must excavate deep enough to isolate the release, and must remove the released product within the excavation zone and the immediately surrounding area. After an investigation of the leak to determine whether, and to what extent, product has reached ground water or soil outside the excavation zone, any free product mounded on the ground-water surface (the floating plume) must be removed.

Three potential approaches for determining the required extent of cleanup activities beyond the first stage are among those used in State UST programs. They are: 1) fixed cleanup standards with a variance provision; 2) site-specific standards selected with reference to the risk posed by particular releases; and 3) a predetermined class approach.

Under the first approach, owner/operators would generally be required to clean up soil and ground water contaminated by an UST release until specified standards are met. The standards would be national health-based standards, including either a few indicator chemicals or all constituents for which EPA has previously developed health-based standards. In the absence of health-based standards, background concentrations would be used to establish cleanup targets. A variance procedure could be used in some circumstances, however, to exempt a particular release from the need to meet the health-based standards. Variances could be based on showing that the health-based standards either could not be met, and/or the release did not present a substantial hazard.

This approach has the potential advantage of providing a degree of certainty and uniformity in cleanups and savings of the costs of setting standards on a site-by-site basis, while allowing for variances to be used where it can be shown that meeting the nationwide standard would be too difficult and/or unnecessary to protect human health. Among its disadvantages are that its implementation would require a considerable delay to allow nationwide standards to be selected; it would not be able to ensure nationwide uniformity in standards because states could set more stringent levels and because the variance procedure would probably have to be used frequently; and the likelihood that even with the variance process, many sites would be subjected to overly stringent cleanups.

A second approach, and the one proposed by the EPA, is to base all long-term (stage-two) cleanup decisions on case-specific exposure and risk assessment techniques. Factors considered under this approach include the quantity, toxicity, mobility, and persistence of the product released, the exposure pathways, the extent of contamination, levels of background contamination, and established standards. The standards established by the site-specific risk analysis could be adjusted under some circumstances on the basis of evidence that they are not practically achievable. These are the same factors that would have to be considered in order to obtain a variance under the nationwide, health-based standards approach.

The advantages of this approach are that it would allow for all of the flexibility of the variance option in the first approach, would save the time required for determining nationwide standards, and would meet the need to protect human health and the environment. One potential disadvantage is that it could be time consuming to implement at each site. However, it is believed that the risk analysis procedures could be streamlined so as to minimize this drawback.

A third approach would combine the national health-based standard and the site-specific standard approaches. It would provide for different cleanup standards for distinct, predetermined situations or classes. This could have advantages similar to the nationwide standards approach, in that it would promote consistency and could avoid delays for setting standards at individual sites, once the class standards had been set and once the class to which each site belonged had been determined. The disadvantage of this approach is that it would involve more time and controversy to set more than one nationwide standard, it would be difficult and time-consuming to determine which sites fell into which classes, and it still might not avoid the need to allow variances in some circumstances.

4.D.2. Effectiveness of Corrective Action

It is very difficult at this time to assess the effectiveness of different approaches to long-term corrective actions. The difficulties stem from uncertainties about the efficiency of free product removal techniques, the cost and effectiveness of dispersed plume cleanups, and the distribution of situations that might fall into one risk and damage class or another. Therefore, rather than try to estimate the effectiveness of different corrective action assumptions, across regulatory options, the analysis for the RIA holds the corrective action option constant, assuming a case-by-case approach to long-term action in which the dispersed plume is removed in a minority of cases. This allows for a truer comparison of options for prevention and detection.

4.D.3 Costs of Corrective Action

The costs of corrective action are difficult to predict because they are subject to so many influences. Costs will be much higher if more corrective action steps are needed (for instance, if floating or dispersed plumes must be removed, rather than contaminated soil only); if release volumes are large and the extent of the contamination is great; and if the standards for cleanup of the soil and ground water and/or the disposal of removed soil and water are stringent. A variety of cost estimates might be obtained even if all of the characteristics of a release and the required cleanup were specified, simply because of differences in technologies and markups used by cleanup contractors.

Nonetheless, EPA has made estimates of the costs of corrective action that vary according to the seriousness of the release and the effect (number of cleanup steps) needed to address it. Exhibit 4.13 shows the typical costs, along with preliminary assumptions about the frequency with which a release would fall into each category. Note that stage two cleanup actions (dispersed plume cleanups) are assumed to be needed for only a fraction of plumes that reach ground water (about 40 percent), and will impose a wide range of costs.

Information about the cost per action and the relative frequencies of each type of action allow us to estimate the average corrective action expenditure. The average expenditure, weighted by its frequency, is about $69,000. (These figures do not include the costs of tank removal and disposal, which can be considered part of the costs of replacing the tank rather than a corrective action cost).

The approach used in the UST Model for determining corrective action costs was very similar, and indeed was based on many of the same underlying assumptions about corrective action technologies and their costs. It differs in that it explicitly recognizes that plumes are less costly to clean up if they have not moved far from their sources. The cost schedule used in the model is shown in Exhibit 4.14. Based on the frequencies of releases of various sizes estimated by the UST Model, the average cost of corrective action in response to a release is about $54,000. This is moderately lower than EPA's weighted average estimate of the costs of responding to a release, though the costing algorithms were designed to approximate EPA's estimate closely. The difference is due to new information on the size of typical floating plumes, showing them to be smaller than previously thought in a given aquifer setting, and new estimates of the distribution of USTs by aquifer type, showing more settings in which plumes tend to be quite small and presumably lower in corrective action costs. The effect of this small difference in corrective action cost assumptions on options selection can be seen in Chapter 5, in the section on the sensitivity of the results to changes in corrective action costs.

Exhibit 4.13

EPA ESTIMATES OF APPROXIMATE COSTS AND PROBABILITIES OF CORRECTIVE ACTION STEPS

STEP	EXPECTED UNIT COST	PROBABILITY PER RELEASE	EXPECTED COST PER RELEASE
IMMEDIATE ASSESSMENT	$ 700	1.00	$ 700
HAZARD MITIGATION	2,000	1.00	2,000
SITE INVESTIGATION	9,500	0.90	8,550
REMOVE & DISPOSE SATURATED SOIL	8,000	0.90	7,200
REMOVE FLOATING PLUME	33,000	0.50	16,500
REMOVE DISPERSED PLUME:			
LOW	75,000	0.05	3,750
MODERATE	150,000	0.05	7,500
HIGH	225,000	0.10	22,500
TOTAL EXPECTED COST:			$ 68,700

Source: Based on data provided by John Heffelfinger, OUST, EPA

Exhibit 4.14

UST MODEL ASSUMPTIONS FOR COSTS OF CORRECTIVE ACTION STEPS

FLOATING PLUME SIZE IN SQUARE METERS:

(costs are in thousands of dollars)

	UP TO: (NONE)	25	750	1500	3500	7500	12500	>12500
INITIAL CLEANUP AND INVESTIGATION, PLUS SOIL REMOVAL	$15.0	$15.0	$15.0	$15.0	$15.0	$15.0	$15.0	$15.0
FLOATING PLUME REMOVAL	0	11.0	24.4	27.3	33.0	39.7	50.8	70.4
DISPERSED PLUME CLEANUP	0	25.2	100.8	120.8	144.2	170.8	218.7	303.0

WEIGHTED AVERAGE COST PER RELEASE ACROSS ALL HYDROSETTINGS FOR BASE CASE: $54,000

Source: UST Model Documentation, assuming half of releases are from tanks and half are from pipes, and with reduced costs ($11,000 for floating plume removal and $25,200 for dispersed plume) for very small plumes (less than the excavation area of the tank, or about 25 square meters).

Chapter 5

ANALYSIS OF COST AND EFFECTIVENESS OF UST REGULATORY OPTIONS

This chapter presents and discusses the results of our analysis of the cost-effectiveness of the UST regulatory options. The framework of the analysis is similar to that of Chapter 4 in that the costs of various regulatory options are presented along with effectiveness estimates. The regulatory options analyzed are packaged options, in that they include rules for new tanks, existing tanks, and corrective action. This shift makes it more difficult to illuminate which components of a given package make the greatest contribution to cost and effectiveness, but allows for the interactions of the various components. In addition, the data are presented for the tank universe as a whole, rather than on a per-tank basis.

5.A. METHODOLOGY FOR CALCULATING COSTS AND EFFECTIVENESS OF THE OPTIONS

This section briefly restates the methodology for generating the costs and effectiveness, which was discussed in detail in Chapters 2 and 3.

5.A.1 The Tank Universe Analyzed

The cost-effectiveness results presented in this chapter are intended to represent results over a 30-year period from all petroleum underground storage tanks covered by EPA's proposed rule. Included explicitly in the analysis are existing tanks in various environmental and exposure settings, of various ages and types, as well as the tanks that will replace them over time. Although the extremely large and varied tank population cannot be modeled in all its detail, efforts were made to allow for the effects of as many important sources of variability as possible. For example, we modeled the age distributions for bare steel and fiberglass tanks as described in Chapter 3 and we modeled bare steel tanks in three hydrosettings (sand, sandstone, and clay). Because fiberglass tanks make up only 11% of the UST population and have fewer releases than bare steel tanks, fiberglass tanks were modeled in only the most prominent hydrosetting (sand). In simulating the UST population we used a scenario-based approach where each scenario represents a subset of the total UST population and is defined by a number of variables, or characteristics, such as hydrosetting, type of monitoring, and tank type. The results were then weighted to reflect what is known about the prevalence of the individual scenarios in the actual population.1/

5.A.2 Measurement of Effectiveness

As described earlier, the effectiveness of the options is estimated by simulating the life cycles of a large number of individual UST facilities with the UST Model to determine the nature of the damages that will occur given a set of regulations. Leak frequencies, timing, and sizes are generated by the failure component of the UST Model. The interaction of these releases with detection and the environment determines how long they continue, how far they spread, and in what concentrations.

1/ The variables considered in building up the scenarios, the distributions of frequencies used, and the number of tank simulations run for each scenario are provided in Appendix C.

In presenting the results of the simulations, a variety of effectiveness measures may be used. Each has advantages and disadvantages, and none is unambiguously superior. Generally, measures like failure frequencies and total release volumes, which can be defined precisely and calculated in straightforward ways, are difficult to relate to the ultimate impacts, like health risks or cleanup costs imposed. Measures more immediately related to these ultimate impacts, though, can be computed and described only with difficulty and uncertainty. This dilemma is fundamental, arising from the complex chain of events that must occur before a failure in an UST system affects society in real ways.

The measure of effectiveness used in this analysis is an output part way between tank failures and the ultimate damages caused by leaks: the areas of the floating contaminant plumes. Effectiveness of the proposed rule is defined as the part of the floating plume area that would have appeared under the base case, but is avoided under the proposal. This intermediate measure of the impact of UST releases has a number of advantages, including that it is fairly straightforward to estimate, easy to visualize, and is directly (though not linearly) related to most final damage measures. Its disadvantages are that it can be translated into ultimate damage measures only with difficulty, it does not include a time dimension, and it does not relate well to damage reduction contributed by corrective action.

5.A.3 Costs as Presented

The same UST Model simulations used to estimate avoided plume areas also calculate the total costs associated with the regulatory options. Costs are limited to those phenomena affected by the proposed rule and include new tank initial facility purchase and installation costs, detection and monitoring costs, value of product lost, tank removal and replacement costs, and pipe repair costs. These costs are summed, discounted to time of promulgation, and summed across the population. A separate category of costs is the cost of corrective action, which will differ according to the stringency of the cleanup. More detailed lists, definitions, and derivations of cost categories are provided in the UST Model documentation.[1]/

All of these costs, when summed, are the costs associated with the regulatory options, and can be compared with the effectiveness of the option in reducing the damages that would occur under the base case.

5.B. REPRESENTATIONS OF THE BASE CASE, THE PROPOSAL, AND THE ALTERNATIVES

The UST Model runs used for the cost-effectiveness analysis are intended to characterize the proposal and other options closely in terms of major provisions, but do not include every detail. The options, as described by EPA, are simulated using the UST Model and the main differences are discussed below.

"No Further Regulation" (Base case): assumes no regulation beyond the interim prohibition requirements; existing tanks are mostly bare steel tanks without supplementary detection or inventory control. Tanks found to be leaking are replaced with corrosion-resistant tanks, which are assumed to be coated and cathodically protected.

1/ Pope-Reid Associates, Inc., Final Report: Underground Storage Tank Model, December 1986

Option I (Baseline level): requires manual inventory control, periodic leak detection within three years for existing and new tanks (five years for corrosion-resistant tanks) , and corrosion-resistance for all replacement tanks. Given that the regulated community is allowed to choose from a variety of detection measures, the option is modeled as though half of operators choose quarterly vapor well monitoring, and the other half choose the less effective tank tightness tests every three years (five years for corrosion-resistant tanks). Tanks are assumed to be replaced with coated and cathodically protected tanks with line leak detectors, and either quarterly vapor well monitoring or tightness tests every five years.

Option II--The Proposed Rule (Enhanced baseline plus targeted upgrading): is similar to Option I with upgrading to new tank standards within ten years, though leak detection systems must be sampled monthly rather than quarterly and tightness tests are not permitted after tanks are replaced. For modeling purposes, operators are assumed to retrofit with cathodic protection and monthly vapor wells to meet new tank standards after eight years. Replacement tanks are assumed to be coated and cathodically protected, to have line leak detectors, and to have monthly vapor well monitoring.

Option III (Baseline plus secondary containment for new tanks): requires periodic leak detection for existing tanks and secondary containment with interstitial monitoring for new tanks. For existing tanks, this option was assumed to be identical to Option I; replacement tanks are assumed to be lined systems with interstitial monitoring.

Option IV (Class Option): requires rapid replacement of existing tanks and secondary containment for replacement tanks at state-designated well-head protection areas. Tanks in other areas are required to conform to baseline standards (Option I). It is assumed that 40 percent of the tank population is located within a well-head protection area. Tanks located in these state-designated areas are assumed to be fitted with continuous vapor wells after one year, and then replaced before the fifth year with protected tanks with liners. The other 60 percent of tanks (those outside well-head protection areas) are modeled the same as Option I. As in other options, ground water is cleaned up at 40 percent of sites where the release has reached ground water; all of these cleanups are assumed to be performed in the well-head protection areas.

Option V (Emphasis on prevention): For existing tanks, this option requires manual inventory control, frequent leak detection starting in three years, and early retirement. Replacement tanks must have secondary containment. Half of all existing tanks are modeled with continuous vapor well monitoring, and half are modeled with monthly vapor well monitoring and three-year tightness tests. Existing tanks are replaced with lined systems either when they fail, or after eight years.

Steps assumed to be taken in response to a release are the same for all options. Where a release has occurred, an investigation and actions to reduce immediate hazards is followed by limited removal of contaminated soil, removal of any free product from the ground water, and ground-water cleanup at 40 percent of sites where ground water has been contaminated.

For all options (except for the "no further regulation" base case) inventory control is modeled as effective in detecting a loss of 0.5 percent of monthly throughput. Inventory control is assumed to be practiced at 25 percent of all establishments.

5.C. COST AND EFFECTIVENESS RESULTS

The cost and effectiveness results are presented in three parts. First, the plume acres avoided by each option are presented along with costs not counting corrective action. The dominated alternatives are identified, and the marginal cost of avoiding damages as more stringent options are used is computed. Next, the difference in cost rankings once corrective action costs are included is shown.

The scales measuring effectiveness in the sections comparing costs and effectiveness with and without corrective action are identical: plume area avoided. Ideally, we would prefer to show some measure of the effectiveness of the options once the benefits of corrective action were considered. Unfortunately, there is little reliable information at this point on the effectiveness of corrective action at alleviating problems once a product has escaped and formed a plume. Until this information is available, it is reasonable to assume that corrective action will not eliminate all of the problems associated with contamination of soil and ground water, and that it will always be more beneficial to avoid a given area of contamination than to clean it up. For this reason, plume area avoided is a useful proxy for the benefits of the standards, even if corrective action is undertaken. It also is a measure of the health risks that are avoided during the time that the plume would have been growing undetected, as well as other "irreversible" damages. In both sections, the incremental cost-effectiveness of one option compared to others is discussed where appropriate.

Finally, the sensitivity of the cost-effectiveness rankings to changes in assumptions is discussed. Among the most important assumptions varied in this section are choices by UST operators among techniques allowed by individual options; the effectiveness of leak detection methods, costs of corrective action, and phasing of the provisions of the options.

The analysis shows that all options could provide a great degree of protection relative to a "no further regulation" base case. The results could also be used to identify the most effective and least costly option. We must caution, though, that this use of the limited analysis presented could be misleading because the ordering of the options in terms of cost and effectiveness is quite sensitive to changes in assumptions (e.g., assumptions about the effectiveness of detection methods). In addition, the identity of the apparent "low cost option" for technical standards is significantly affected by assumptions regarding the appropriate level of corrective action.

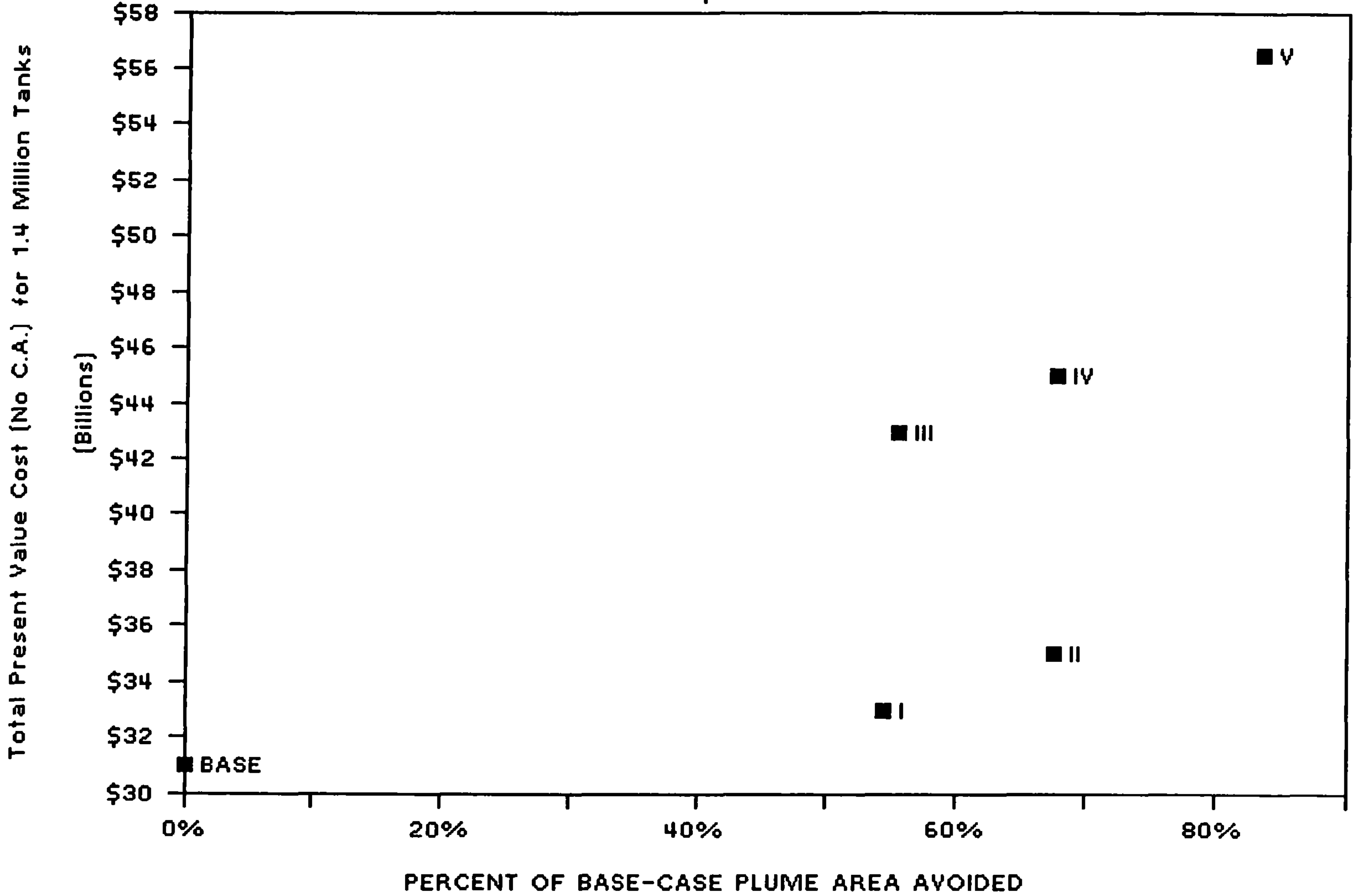
5.C.1. Comparisons Without Corrective Action

5.C.1.a. Total Cost-Effectiveness Comparisons

Exhibit 5.1 shows the cost and effectiveness of the technical standards of each of the five regulatory options compared to the base case. It does not

COST AND EFFECTIVENESS OF OPTIONS

30-YEAR COSTS, NO CORRECTIVE ACTION



Source: SCI and PRA Estimate Using UST Model

Exhibit 5.1

include the costs of corrective action regulations. Exhibit 5.1 shows that all the options can provide substantial improvements over the base case: at least 55 percent and as much as 83 percent of the floating plume area that would occur under the base case is avoided by each option. The more protective options are generally shown to be more costly (taking into account any savings in costs of repair, replacement, and lost product, but excluding consideration of any savings of corrective action costs), since they require earlier and more expensive upgrading of existing tanks. The data on which Exhibit 5.1 was based are presented, for reference, in Exhibit 5.2.

The main reasons for this improvement over the base case are the inventory control requirement, the requirement of periodic to frequent monitoring for existing tanks in each option, and tank upgrading or replacement. Any program requiring at least inventory control in combination with periodic leak monitoring can alleviate a large portion of the potential damage from leaking underground storage tanks, and early retirement or upgrade will reduce damages even more.

5.C.1.b Incremental Cost Comparisons

As discussed earlier, it is often useful to calculate the incremental costs per unit of increased effectiveness as we move from a given option to one that is both more costly and more effective. When examining Exhibit 5.1, for instance, we are interested in knowing how costly Option I is per unit of increased effectiveness compared to the base case. By dividing the increased cost by the reduction in the number of plumes that occur with Option I, we obtain an incremental cost per plume of $31,654. This may be compared to EPA's estimate of the cost of cleaning up a typical base-case plume of at least $33,000 (for floating plume removal alone; see Chapter 4) suggesting that the cost of Option I is worth paying when Option I is compared to the base case.

Similar comparisons can be made between Option I and Option II and between Option II and Option V. The cost per plume avoided by choosing Option II over Option I is only $3,862, suggesting that Option II is likely to be a cost-effective choice compared to Option I. The next comparison, between Option II and Option V, shows a significantly higher cost per avoided plume of $39,325. Depending on the costs of cleaning up plumes and the value of avoiding the residual or irreversible damages that remain even after the plumes have been cleaned up, Option V may be a better choice than Option II. This question will be further illuminated in the following section, which examines the options with corrective action costs included.

Finally, it is interesting to compare Option III to Option I, even though Option III is dominated by Option II, because this comparison shows the incremental cost per avoided plume of requiring secondary containment for replacement tanks. The incremental cost (which, like all of the costs presented here, is a discounted present value cost) comes to $61,723 per plume. This is a high cost compared to the costs per plume avoided for the other comparisons. However, it still might be worth paying for the costs of secondary containment under some circumstances.

The incremental cost comparisons, including comparisons after corrective action costs are included, are presented in Exhibit 5.3.

Exhibit 5.2

SUMMARY OF SIMULATION RESULTS FOR CURRENT UST POPULATION
(1.4 MILLION TANKS)

	TOTAL RELEASE VOLUME (Millions of Gallons)	NUMBER OF INCIDENTS (Thousands)	NUMBER OF PLUMES (Thousands)	NUMBER OF PLUMES > 25 m^2 (Thousands)
BASE CASE	8,647	2,668	1,975	1,438
OPTION I	4,055	2,921	1,913	999
OPTION II	2,912	2,158	1,390	590
OPTION III	3,889	2,645	1,751	944
OPTION IV	2,866	2,114	1,396	671
OPTION V	1,530	1,271	844	289

	PLUME AREA (Thousands of Acres)	% AREA AVOIDED	COST NO CA ($Billions)	COST W/CA ($Billions)
BASE CASE	190	0.0%	$31.00	$120.81
OPTION I	87	54.4%	32.96	113.90
OPTION II	62	67.5%	34.98	94.75
OPTION III	85	55.4%	42.96	118.56
OPTION IV	61	67.8%	44.97	95.04
OPTION V	31	83.5%	56.47	97.08

Exhibit 5.3

INCREMENTAL COST EFFECTIVENESS COMPARISONS

	INCREMENTAL DISCOUNTED COST PER:			
	PLUME AVOIDED	PLUME > 25 M^2 AVOIDED	PLUME ACRE AVOIDED	GALLONS OF RELEASE AVOIDED
WITHOUT CORRECTIVE ACTION:				
FROM BASE CASE TO OPTION I	$31,654	$ 4,476	$ 18,980	$ 0.43
FROM OPTION I TO OPTION II	3,862	4,491	80,900	1.77
FROM OPTION II TO OPTION V	39,325	71,424	706,228	15.55
FROM OPTION I TO OPTION III	61,723	182,063	5,068,266	60.35
WITH CORRECTIVE ACTION:				
FROM OPTION II TO OPTION V	$ 4,264	$ 7,745	$ 76,576	$ 1.69
FROM OPTION I TO OPTION III	28,785	84,908	2,363,669	$ 28.15

5.C.2. Changes in Comparisons When Corrective Action Costs Are Included

5.C.2.a. Total Cost-Effectiveness Comparisons

Exhibit 5.4 shows the dramatic change in both absolute and relative costs of the options when the costs of EPA's corrective action requirements are included. If corrective action costs are included in the base case, it jumps from the lowest in cost to the highest in cost. This is because it is so lacking in protection that the cost of cleaning up the plumes it allows to occur is extremely high. At the opposite extreme, the most costly and protective technical options are revealed to save more in avoided corrective action than their incremental cost for prevention and detection.

Exhibit 5.5, by focusing only on the options, makes it easy to compare the relative cost and effectiveness between the options. Options II, IV, and V are shown to be the most cost-effective options. This illustrates the effectiveness of both early retirement, or upgrade, of bare steel tanks and frequent leak detection. The relative cost effectiveness of Option V also illustrates that the most effective regulatory alternatives can, in theory, be close to the least costly in the long run. This is because effective leak detection and early replacement with corrosion-protected, lined tanks eliminates a large portion of potential corrective action costs. This result, of course, depends on the unit cost and intensity of corrective action assumed to be appropriate and does not reflect implementation concerns associated with the options.

Option III is the most costly alternative because tanks are replaced with secondary containment only after they leak. Corrective action costs are higher than the corrective action costs for the options requiring mandatory upgrade or retirement before the existing tank fails. Option III also has high facility costs due to the secondary containment requirement for new tanks. Though Option III is effective, eliminating 56 percent of the potential plume area, it is more costly than other options which have the same or better effectiveness.

Option IV, which is a combination of the less-stringent Option I at some sites and a very stringent set of rules at other sites, is shown to be virtually the same in cost and effectiveness as the moderately-stringent Option II. That these options are so close together is largely coincidental. Small changes in some of the assumptions of the analysis or in the definition of Option IV might demonstrate that a class option could be the least-cost option, before accounting for implementation costs.

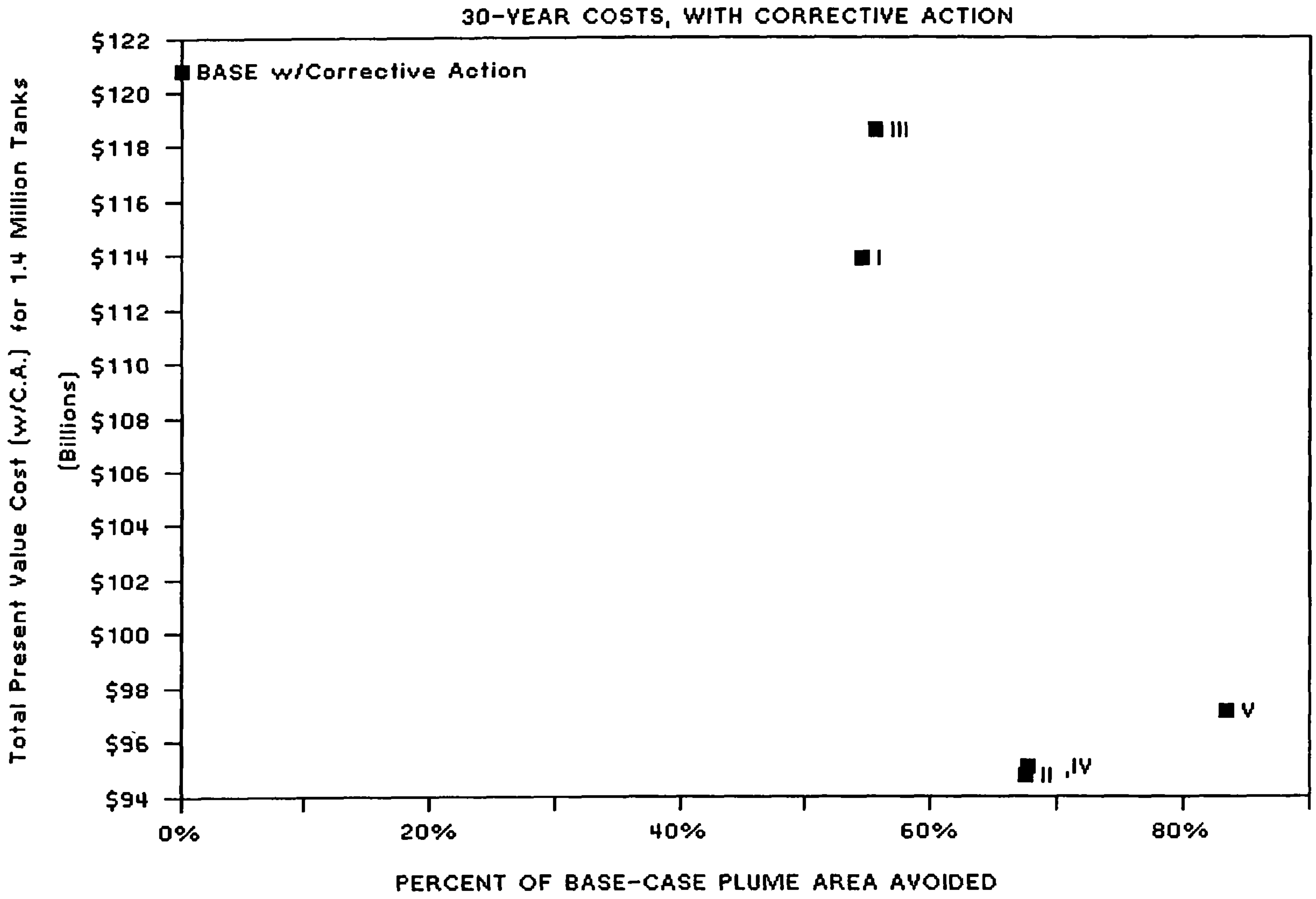
One important note regarding Exhibit 5.5: it tends to make the cost differences and the differentials in effectiveness between options appear dramatic if one does not keep in mind the small scale. In Exhibit 5.3 it is more obvious that, compared to the base case, any of the options can make a large difference in the damages that can be attributed to leaking underground storage tanks in the near future; the differences across the options are somewhat smaller by comparison. In addition, the differences highlighted by 5.5 may not be reliable, because of the sensitivity of the exact results to changes in assumptions. This issue is discussed in Section 5.C.3.

5.C.2.b Incremental Cost-Effectiveness Analysis

Referring to the last two lines of Exhibit 5.3, we see the extent to which the added protection provided by secondary containment for replacement tanks

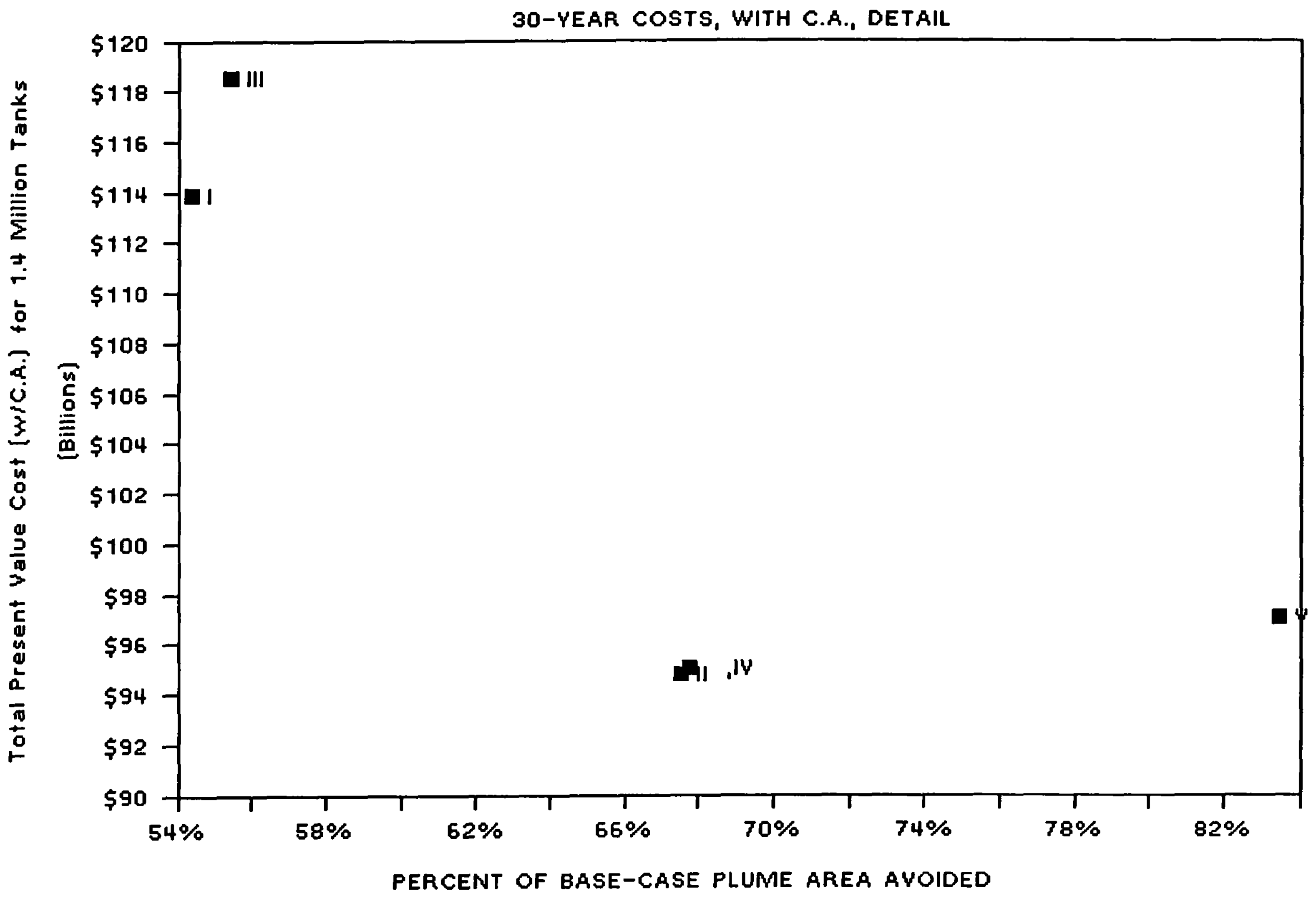
Exhibit 5.4

COST AND EFFECTIVENESS OF OPTIONS



Source: SCI and PRA Estimate Using UST Model

COST AND EFFECTIVENESS OF OPTIONS



Source: SCI and PRA Estimate Using UST Model

Exhibit 5.5

and/or early retirement fall short of paying for themselves in reduced corrective action costs. We can interpret the results as follows: those plume-related damages that cannot be reversed by corrective action would have to be valued at more than $4,264 per plume to make Option V attractive relative to Option II, and $28,785 per plume to make Option III preferable to Option I.

5.C.3 Sensitivity of Results to Assumptions

The cost and effectiveness of the options is strongly affected by several of the assumptions used in the analysis of the options: operators' choices for meeting the requirements of an option, (e.g.: replacement rather than upgrading), corrective action costs, detection effectiveness, retrofit effectiveness, hydrosetting distributions, discount rate, and phasing deadlines for implementation. The sensitivity of the results to these issues is discussed in the sections that follow.

5.C.3.a. Option Choice

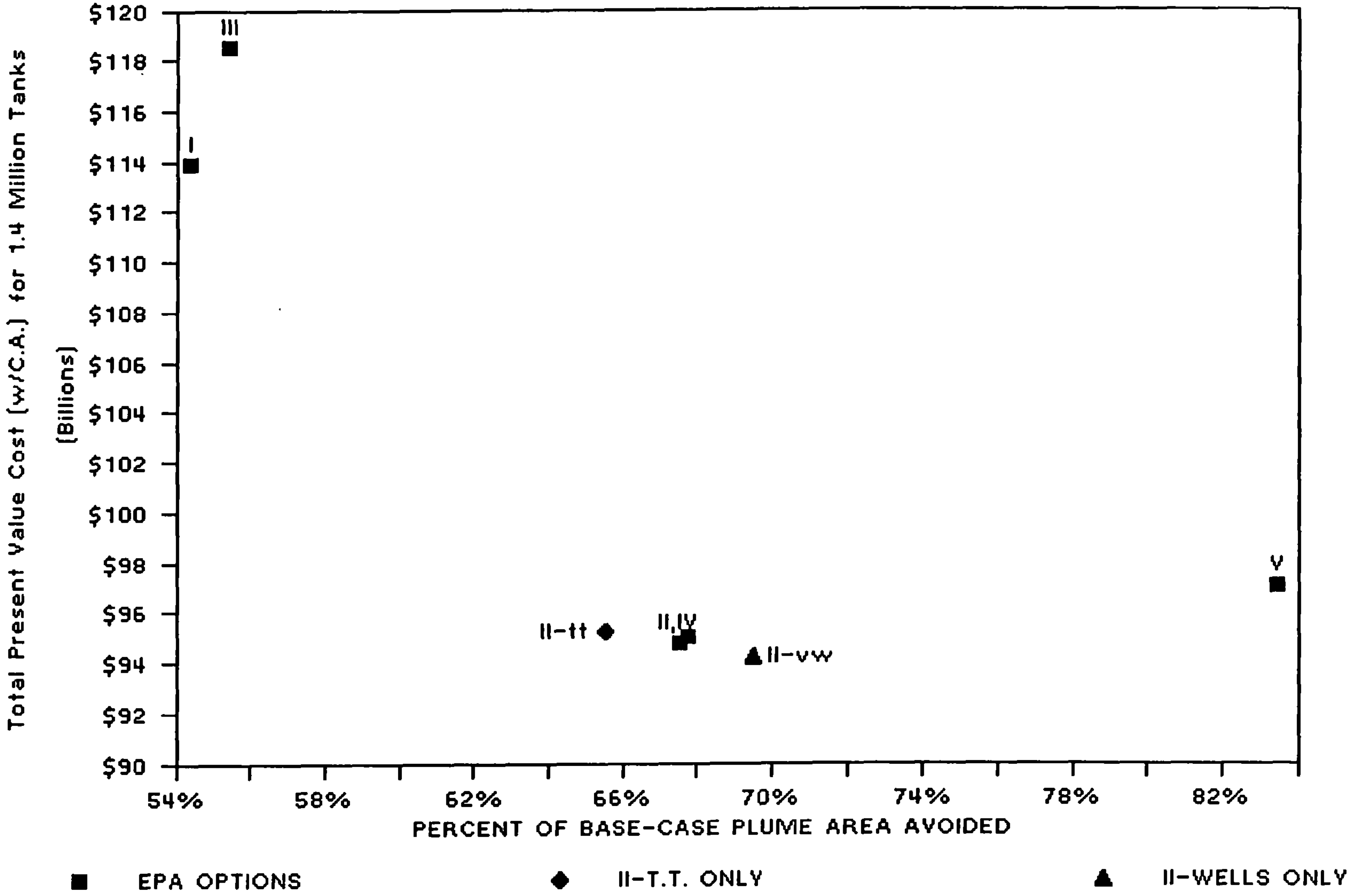
One important source of uncertainty in predicting the effects of the options is that many options allow choices. Option II, for instance, allows the operator to choose between monthly vapor wells and tightness tests every three years. It is assumed that half of tank owners choose each method, but there is no way to be sure how the owners would actually choose. These choices are important because the two methods result in a difference in cost and effectiveness for Option II, as illustrated in Exhibit 5.6. Exhibit 5.6 shows the options as modeled, and in addition it shows where Option II would fall if all facility owners chose tightness tests (II-tt) and if all owners chose vapor wells (II-vw). The difference is very small in terms of cost, but larger in terms of effectiveness. Still, it affects the ranking of Option II only in comparison with Option IV.

5.C.3.b. Sensitivity to Corrective Action Costs

The level of corrective action required and the estimated cost of corrective action will affect both the absolute cost of the options and the relative cost between options. As corrective action costs increase, the overall (absolute) cost of the options increases. Also, increasing the estimated costs for corrective action will cause more stringent options, those requiring frequent leak detection or early upgrading/retirement for existing tanks and/or secondary containment for new tanks, to appear to be (relatively) more cost effective. Frequent leak detection, early retirement and secondary containment decrease the likelihood of having to do extensive corrective action, and therefore the total cost advantage of these options compared to less-protective options will be enhanced as per-incident corrective action costs rise. This effect is illustrated in Exhibit 5.7, which shows the effectiveness of the options compared to their costs calculated three ways: using the UST Model estimates of per-incident corrective action costs (which, as discussed in Chapter 4, are slightly lower than EPA's current estimates of costs); using per-incident costs half as great as the UST Model costs; and using costs twice as high. Under the low corrective action cost scenario, Option II has the lowest total cost, and two of the options (III and V) are actually higher in total cost than the base case (even if corrective action costs are attributed to it). Under the high cost scenario, the relative positions of the options change dramatically: IV and V drop below II in total cost, and III drops below I. This shows that more protective steps,

COST AND EFFECTIVENESS OF OPTIONS

VARIATION DUE TO DETECTION CHOICES

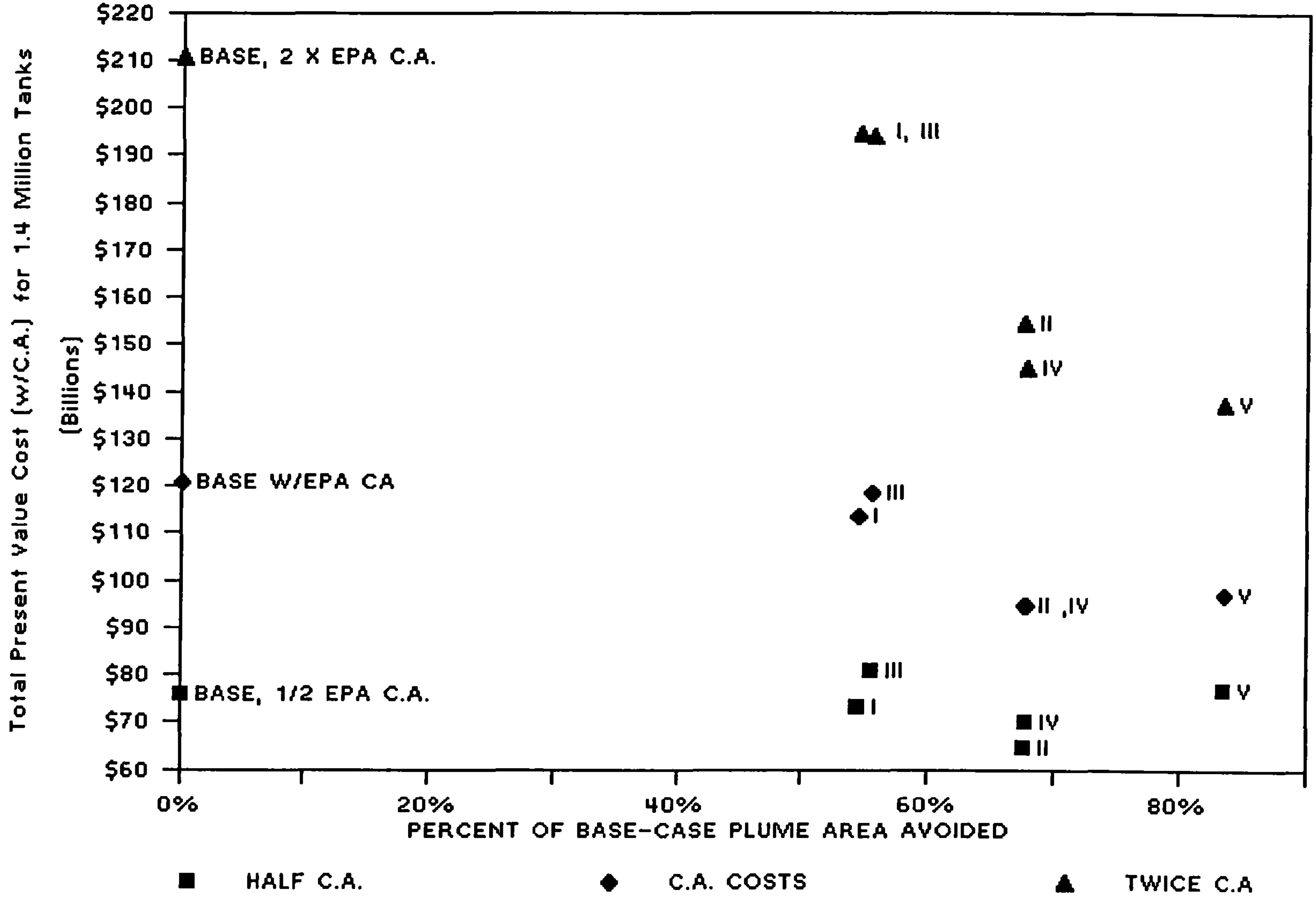


Source: SCI and PRA Estimate Using UST Model

Exhibit 5.6

COST AND EFFECTIVENESS OF OPTIONS

VARIATIONS ON CORRECTIVE ACTION COSTS



Source: SCI and PRA Estimates Using UST Model

Exhibit 5.7

including secondary containment for replacement tanks, could be cost-effective if unit corrective action costs turn out to be higher than current estimates. In addition, it means that if hydrogeological settings resulting in unusually high corrective action costs could be identified a priori, then more stringent options could be cost-effective in those settings even if they are too expensive to require everywhere.

Total corrective action costs could vary from those presented here even if the unit costs of given corrective action steps (excavating contaminated soil, floating plume removal, ground-water cleanup) have been estimated correctly. Current EPA estimates are that ground-water cleanups will be required for 40 percent of contamination, but it is possible that fewer cleanups (or more cleanups) will ultimately be performed. Exhibit 5.8 shows the changes in the rankings of the options assuming ground water is cleaned up at 20 percent of all sites instead of the current EPA assumption of 40 percent. Again, the less-- protective options look relatively better compared to the more stringent options, with Option II definitely lowest in cost.

5.C.3.c. Sensitivity to the Effectiveness of Retrofitting Cathodic Protection

One of the most important features of the proposed option (Option II) is the requirement that existing tank systems be upgraded to new tank standards within ten years. As described earlier in this chapter, the requirement that tank systems be protected from corrosion was assumed to be met by retrofitting cathodic protection after eight years, a step that was assumed to be completely effective in stopping localized corrosion. (Many tank operators would actually choose to replace their tanks instead of retrofitting them. This choice was not modeled because it goes beyond the requirements of the proposal.) Because there is no extensive body of data on the effectiveness of retrofitted cathodic protection (RCP), it is at least possible that it will not work as well as it is modeled. To show the sensitivity of the results to assumptions about the effectiveness of RCP, a few additional model runs were made that allow us to make rough comparisons between the proposal with 100% effective RCP (Option II-100% RCP) and the same proposal with RCP operating at an arbitrarily selected lower effectiveness level of 50% (Option II-50% RCP). In other words, at half of all tanks where CP is added to existing tanks, it imposes costs but has no effect at all on corrosion (a fact which is assumed not to be detectable in the inspection of the CP system). 1/

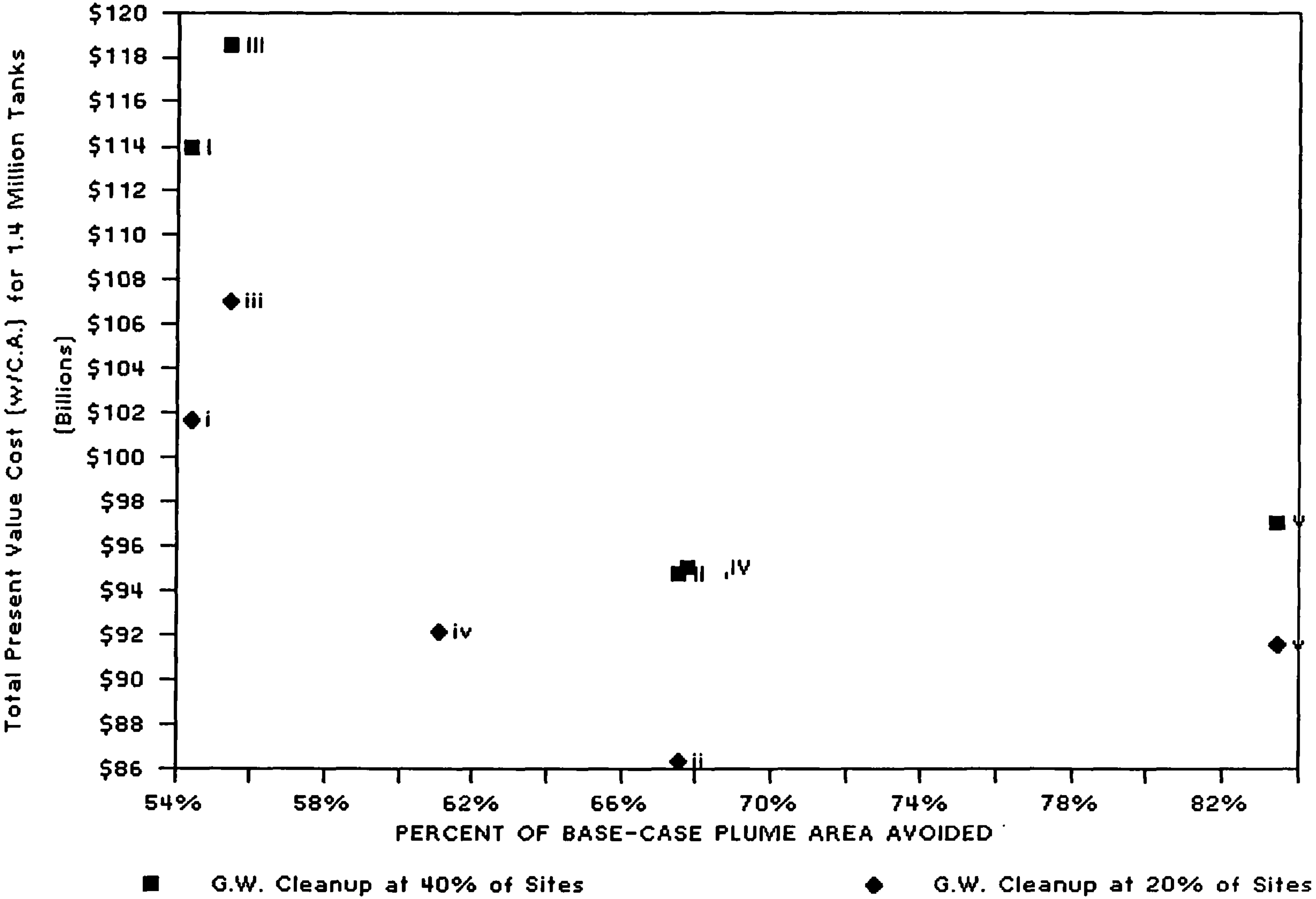
The results show that Option II-50% RCP would fall roughly halfway between the Option II-100% RCP, and Option I. Just over 2% less base-case plume area would be avoided compared to Option II-100% RCP. The costs of lost product and added corrective action (mostly the latter) would be about $7 billion higher, and added tank replacement due to increased existing tank failures would add about $3 billion. The current measured difference between Option II-100% RCP and Option I is about $20 billion, so Option II would still be superior to Option I even if RCP were effective for only half of the tank population. On the other hand, Options IV and V would clearly dominate Option II in terms of cost and reduced plume area if RCP worked only half the time.

1/ The added model runs were not comprehensive. Rather, they examined only cases in which the existing tanks were bare steel. In addition, the runs for the replacement tanks were not redone; instead, the results for the replacement tanks were approximated closely using very similar replacement runs for Option I.

Exhibit 5.8

COST AND EFFECTIVENESS OF OPTIONS

Ground Water Cleanup at 20% of Sites vs. at 40% of Sites



Source: SCI and PRA Estimate Using UST Model

5.C.3.d. Sensitivity to the Effectiveness of Leak Detection

Much of the effectiveness of the proposed option is attributable to the use of leak detection to allow leaks to be stopped either before they contaminate ground water or while the extent of the contamination is still small.

The rapid detection of small leaks from USTs is, however, a difficult task under field conditions. It can be taken for granted that any given detection method will in some cases fail to detect leaks of the magnitude that they were designed to handle. For this reason, tightness tests and vapor wells were not modeled to be perfect.

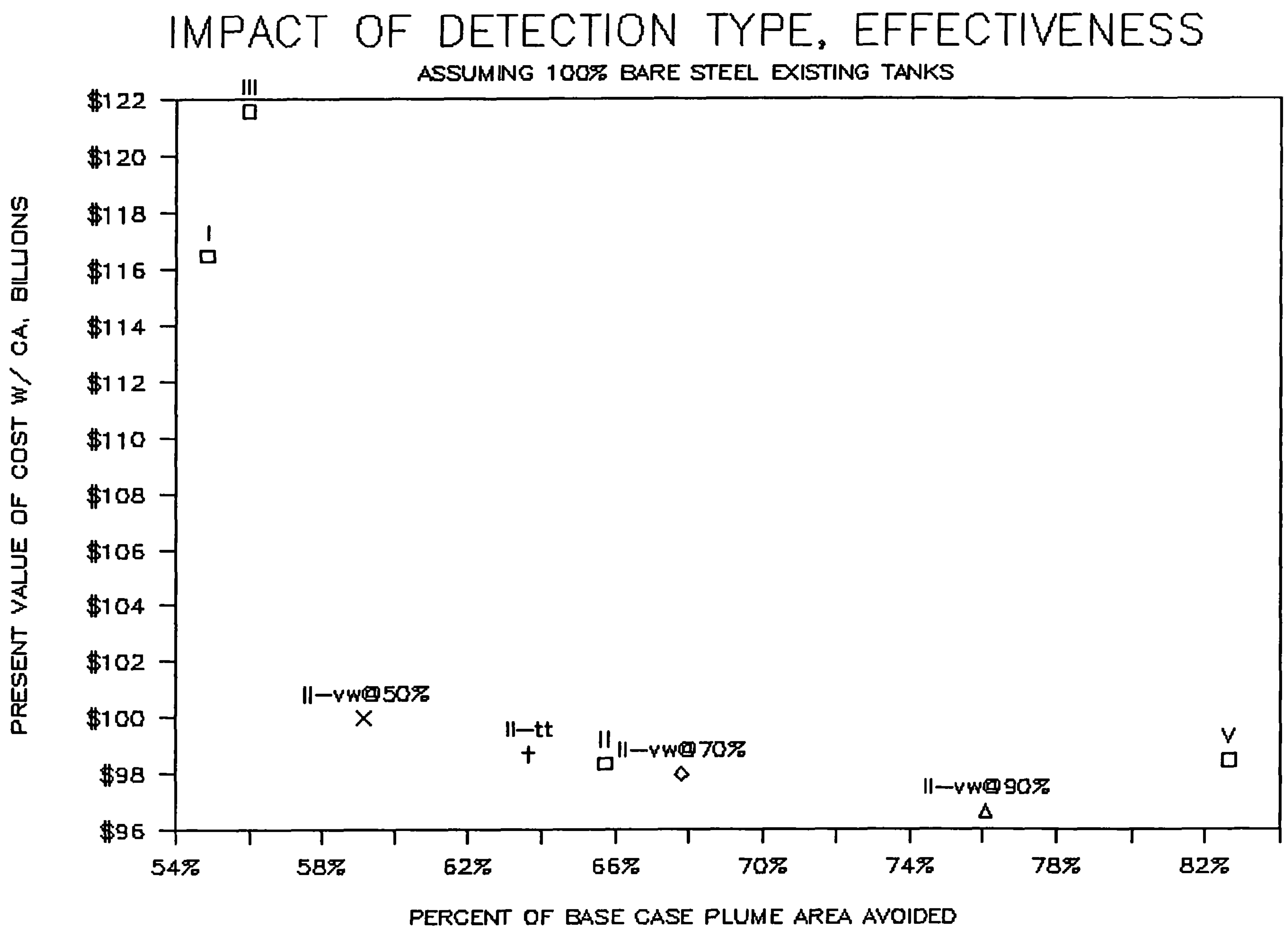
Unfortunately, while test data could be used to establish that per-test reliability of tightness tests is at least 90% (which is the level used in the modeling), no comparable information could be located for vapor wells. EPA's decision, based on engineering judgment, was to assume that vapor wells could be expected to work as designed at between 50 and 90 percent of the sites at which they were installed. The model runs assumed that vapor wells worked at 70 percent of sites.

A number of additional runs were performed assuming 50 percent effectiveness or 90 percent effectiveness to test the sensitivity of the results to this important parameter. 1/ The results show that the effectiveness of Option II varies significantly with the assumed reliability of vapor wells, while the costs of the option, including corrective action, are relatively unaffected. Exhibit 5.9 shows a cost-effectiveness display similar to that of Exhibit 5.6 (which concerned sensitivity to the choice of detection methods) except that it assumes that all existing tanks are bare steel. It also omits Option IV for clarity, and includes two added data points: II-vw@90% and Option II-vw@50%. These two points indicate the cost and effectiveness of Option II if all operators chose vapor wells, and if vapor wells worked at 90 percent and 50 percent of sites, respectively. 2/ The modeled differences in vapor well effectiveness are more important than the differences between vapor wells and tightness tests. The differences between Option II-vw@50% and Option II-vw@90% are of about the same magnitude as the differences among Options I, II, III, IV, and V.

The differences in costs are smaller, apparently because the primary effect of properly functioning monthly vapor wells is to reduce the size of plumes rather than to prevent them. Costs of corrective action do not show a strong enough dependence on plume size to allow monthly vapor wells to have a large effect on the costs.

1/ As with the sensitivity runs for the effectiveness of RCP, these runs were performed only for bare steel and existing tanks. Thus, the comparisons approximate closely, but not exactly, the results that would be obtained if all of the runs had been redone.

2/ Note that for the other options, the reliability of vapor wells is held constant at 70 percent, and that of tightness tests is assumed to be 90 percent for all of the runs.



IMPACT OF DETECTION TYPE, EFFECTIVENESS
ASSUMING 100% BARE STEEL EXISTING TANKS
PRESENT VALUE OF COST W/ CA, BILLIONS
$122
$120
$118
$116
$114
$112
$110
$108
$106
$104
$102
$100
$98
$96
54%
58%
62%
66%
70%
74%
78%
82%
PERCENT OF BASE CASE PLUME AREA AVOIDED
III
I
II—vw@50%
II—tt
II
II—vw@70%
II—vw@90%
V

Exhibit 5.9

5.C.3.e. Sensitivity of Option Rankings to Estimates of Hydrosetting Distributions

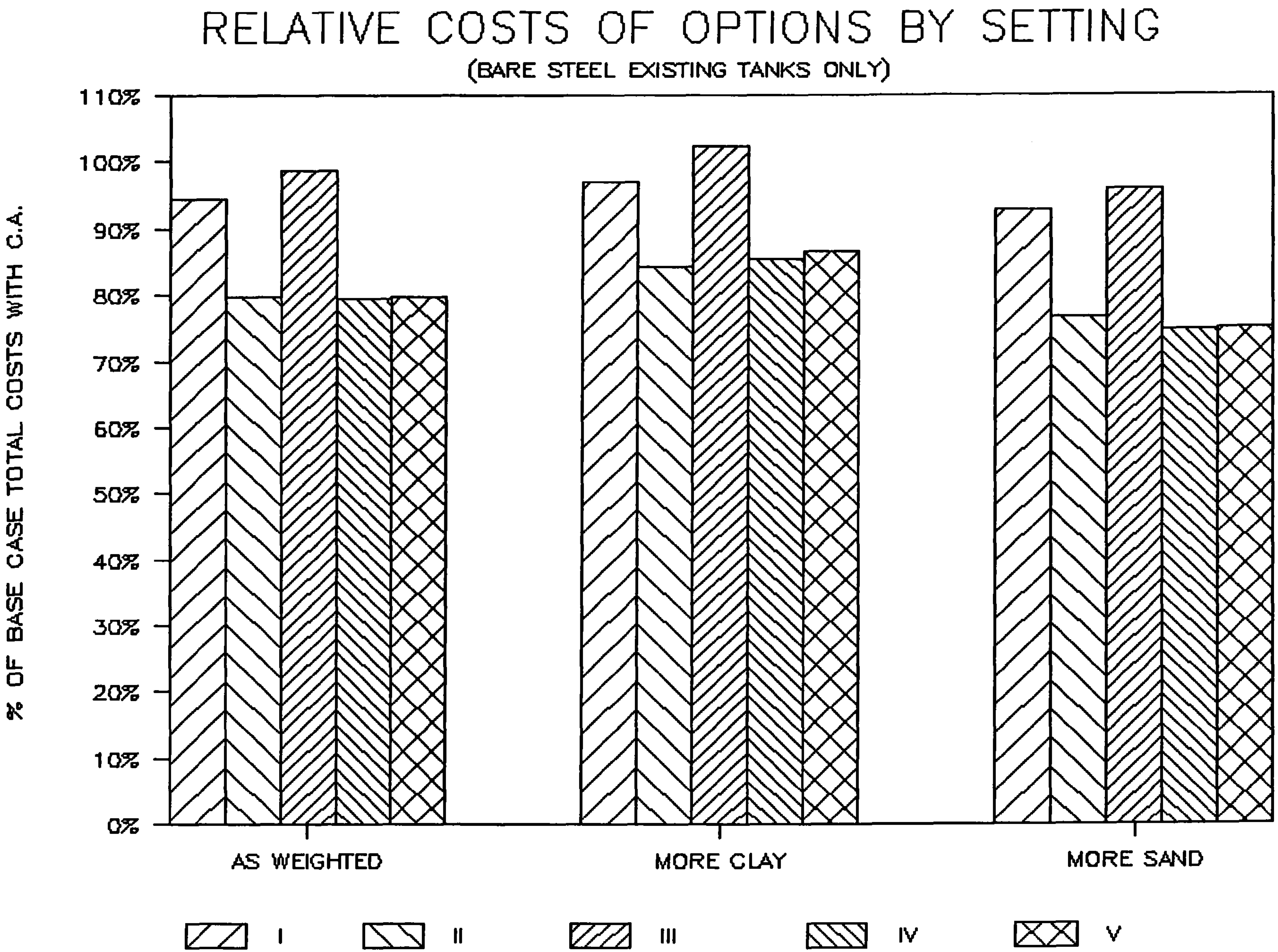
The basic analysis of the cost effectiveness of the options assumes that USTs are distributed across hydrogeological settings with three representive soil (or subsoil) types: sandstone/limestone/shale; sand; and clay/silt. These media types have moderate, high, and low degrees of permeability, respectively. The modeling assumed that about 21 percent of USTs are found in the moderately permeable settings, 40 percent in the highly permeable settings, and the remaining 39 percent in the low permeability settings. These distributions were based on careful assessments of available county-level data on USTs and hydrogeological characteristics, but it is still possible that they differ from the (unknown) actual distributions.

The permeability of the subsurface media surrounding an UST can have significant effects on the relative effectiveness of options for prevention and detection of releases because it affects the time it takes for a release to hit ground water and effects the ultimate size of any floating plumes. Thus, an option that is valuable if it detects leaks before they contaminate ground water or before the contamination spreads might be much more effective if most USTs are in low permeability settings rather than in high permeability settings, depending on the time needed for the detection method to catch a leak. For this reason, the sensitivity of the ranking of the options to differences in the distribution of settings was assessed by re-weighting and combining existing model runs in the three settings. Exhibit 5.10 shows the relative costs of the options assuming three different setting distributions: first, the distribution developed by PRA Inc. for the analysis; next, a distribution with many more highly permeable settings and fewer low permeability settings (half of the clay/silt settings were changed to sand settings); and finally one with many more low permeability settings (half of the sand settings were moved into the clay/silt category). The exhibit shows that the cost rankings change only for groups of options that are very close together in costs: Option II is the least expensive option with relatively more low permeability settings, but it would be somewhat more costly than the more stringent options if relatively more settings were in the high permeability category. Relative differences in effectiveness are similarly small.

In conclusion, the basic findings of the cost-effectiveness analysis are robust even to substantial changes in soil/subsoil types. Tailoring of options with respect to setting may still be worthwhile if more stringent requirements could be imposed at sites with more permeable hydrogeological settings.

5.C.3.f. Sensitivity to Changes in the Discount Rate

Costs in this analysis were discounted to the first year of the regulations at three percent per year, the rate chosen by EPA to represent the difference between the value to society of a dollar today compared to a dollar next year. The discount rate is important because many of the regulatory choices involve the decision to spend money now in order to avert costs that would appear many years in the future.



RELATIVE COSTS OF OPTIONS BY SETTING
(BARE STEEL EXISTING TANKS ONLY)
% OF BASE CASE TOTAL COSTS WITH C.A.
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
AS WEIGHTED
MORE CLAY
MORE SAND
I
II
III
IV
V

Exhibit 5.10

Because the use of different discount rates could change the relative attractiveness of the options, we recalculated the present value of the total costs of the options at two additional rates: ten percent per year, the rate recommended by OMB, and zero percent. Total costs are much lower with a ten percent discount rate than with the lower rates, because costs that will be incurred years in the future (e.g., costs of tank replacement and corrective action) are dramatically reduced at high discount rates. Perhaps more important, from the standpoint of option choice, the individual options are affected differently by the discount rate. Exhibit 5.11 shows that the more stringent options, IV and V, are much more attractive compared to Option II at low discount rates. Careful attention should be paid, therefore, to the question of whether the appropriate discount rate is high or low.

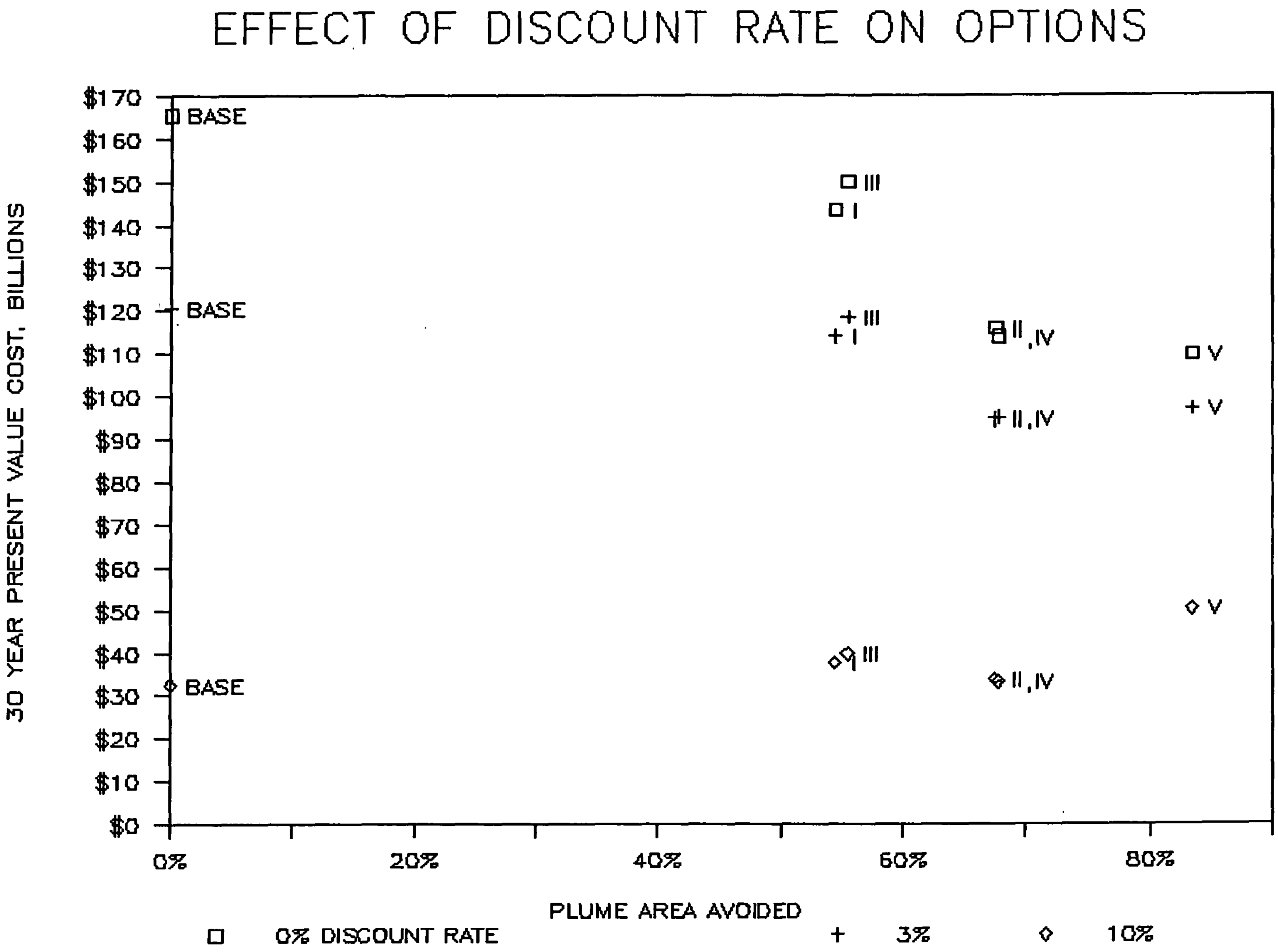
5.C.3.g. Sensitivity of the Choice of Secondary Containment to the Prevalence of False Reports of Leaks

We have already discussed the fact that some leak detection methods are less likely than others to miss an actual leak. There is also concern that some methods will be more likely to indicate that a release is taking place when it is not. This can be called a "false positive" or a "false alarm." Two of the most likely cases in which this could happen are if a tightness test is used on a tank with a loose fitting at a connection above the highest levels at which that product is stored, and if a vapor well is used at a site where very small surface spills take place, or where there is residual contamination from an earlier release. A false alarm does no damage to the environment, but could impose significant costs on operators who must either expend resources on starting a corrective action procedure or on trying to confirm the existence of a release.

The questions raised by the added costs imposed by false alarms are most important when we compare two options that we expect to differ greatly in vulnerability to sounding false alarms. For instance, because the interstitial monitor of a system with secondary containment can be easily isolated from outside influences, it might be much less likely to sound false alarms than a vapor well, which operates outside a single-wall tank. Though secondary containment is expensive, it may be less costly than single wall systems with vapor wells, even excluding the costs of corrective action, if it prevents expensive false alarms.

Unfortunately, there is no reliable information available on either the costs or frequencies of false alarms for various detection systems. We can, however, calculate the effect of different possible values for the costs and frequencies of false alarms on the choice of options as a first step toward addressing this issue.

Exhibit 5.12 shows the impact of a set of possible false alarm frequencies for given present value costs per false alarm on the relative merits of two options: Option I and Option III. These options differ only in that Option III requires replacement systems to employ secondary containment (assumed to be a liner), while Option I requires single-wall, protected tanks and leak detection. Option III is more costly, without accounting for the corrective action costs it would save, but would prevent most of the plumes that would occur under Option I.



EFFECT OF DISCOUNT RATE ON OPTIONS
30 YEAR PRESENT VALUE COST, BILLIONS
$170
$160
$150
$140
$130
$120
$110
$100
$90
$80
$70
$60
$50
$40
$30
$20
$10
$0
BASE
BASE
BASE
III
I
III
I
II
IV
V
II, IV
V
V
III
I
II, IV
0%
20%
40%
60%
80%
PLUME AREA AVOIDED
0% DISCOUNT RATE
3%
10%

Exhibit 5.11

Exhibit 5.12

EFFECT OF ASSUMED COSTS OF FALSE ALARMS ON INCREMENTAL COSTS

Incremental Cost Per Plume (of any size) Avoided between Options I and III

ASSUMED NUMBER OF FALSE ALARMS PER SYSTEM OVER 30 YEARS	ASSUMED P.V. OF COST PER FALSE ALARM: $1,000	$1,500	$3,000
0	$ 61,723	$ 61,723	$ 61,723
2	44,439	35,798	9,873
4	27,156	9,873	(41,978)
6	9,873	(16,052)	(93,828)

The table shows the discounted incremental cost of choosing Option III over Option I per plume avoided. Unless the discounted costs of corrective action are substantial, or false alarms are a significant problem for Option I, Option III will not be cost-effective compared to Option I.

If, however, we expect two more false alarms under Option I per thirty years, no false alarms under Option III, and a cost per false alarm of $1,500, the incremental cost per plume avoided is cut almost in half. This is because the net cost of choosing Option III over Option I is reduced by several thousand dollars. If four more false alarms are expected (or if each one imposes costs twice as high), the two options would be nearly equal in costs excluding corrective action: the incremental cost per plume avoided for Option III would drop below $10,000. With the assumption of six more false alarms per thirty years, each at a cost of $1,500, Option III dominates Option I, saving money and reducing the number of plumes. The fact that the false alarm issue shows the potential to swing the cost rankings of single-wall construction vs. secondary containment argues that research into the expected frequency of false alarms and their costs should be part of any investigation of leak detection methods.

5.C.3.h. Phasing of Option Provisions by Age or Risk

It seems clear that the sooner the detection and upgrading provisions of the proposed regulation (as well as similar provisions of the other options) are implemented, the more damage from leaking USTs can be avoided. The proposal allows leak detection to be implemented over the next three to five years, and upgrading over the next ten years, largely because it is recognized that capacity problems would prevent the industry from implementing detection and upgrading all at once.

The fact that the industry will end up complying with the regulations slowly, over a number of years, suggests that it might be important to control which tanks meet the regulations sooner, and which ones later. That is, the regulations could be phased in over a number of years, with provisions to ensure that the tanks posing the most danger, if left alone, are brought into compliance first.

Two attractive systems for the phasing of leak detection and upgrading are by tank age and by potential risk imposed by a release. Under the first system, older tanks could be required to be in compliance sooner than younger tanks. Under the second, tanks within a relatively short distance of drinking water sources (the same tanks at which, it is assumed, ground-water cleanups would be needed) would comply first.

To test the potential of these phasing plans, some additional runs of the UST Model were made. Phasing by age was tested only for Option II, only for bare steel existing tanks, and in only one hydrosetting (sandstone/limestone/shale, which has moderate permeability). For the oldest 36% of tanks in the run, those 25 years or older, detection was assumed to be implemented in two years instead of the three years assumed in most of the runs for Option II. Similarly, tank upgrading was assumed to take place after five years for the older tanks, instead of eight years. For the younger tanks, detection and upgrading were delayed to the fourth and tenth years respectively.

Phasing of Option II by risk was examined in a manner very similar to that used for phasing by age. The differences being that, for risk, phasing all three hydrosetting types were modeled. Age was ignored in determining which tanks would phase in detection and upgrading at years 2 and 5 instead of 4 and 10. It was also assumed that dispersed plume cleanups are required only for those tanks where detection and upgrading are phased in early.

The results for phasing by age are ambiguous. Compared to an unphased Option II, age-based phasing reduces cumulative releases and plume areas moderately, with plume area avoided in comparison to the base case rising from 67 percent to almost 72 percent. Costs after corrective action, however, turned out to be marginally higher under age-based phasing, largely because the total number of plumes grew slightly. The results on comparative costs are probably sensitive to the degree to which corrective action costs rise with the magnitude of the release.

The results for phasing by risk are quite different from the age-based results. Plume areas are barely reduced at all, since no attempt was made in this phasing scheme to implement the regulations sooner for tanks that are more likely to fail. Total costs, however, are lower by a substantial $4.65 billion, or are lower by over 7 percent of the total costs of the regulations for existing tanks. The cost savings arise from the fact that it is assumed the regulations would be phased in first at those sites where ground-water cleanups would be required in the event of a plume.

Chapter 6

ECONOMIC IMPACTS OF UST TECHNICAL STANDARDS AND REGULATIONS

6.A INTRODUCTION AND METHODOLOGY

The regulated community affected by the proposed regulations can be divided into three sectors, each of whose impacts can be evaluated separately. They are, in order of decreasing number of tanks owned:

- o Facilities using USTs for storing motor fuels for the retail market (see Section 6.B);
- o Facilities using USTs for storing motor fuels for nonretail purposes (see Section 6.C); and
- o Facilities using USTs for storing regulated chemicals (see Section 6.D).

Of these, the retail motor fuel sector presents the greatest potential for economic dislocation because:

- o There are no substitutes for USTs;
- o There are at least three USTs per facility (one for each grade of gasoline);
- o UST costs represent a significant fraction of capital and operating costs for the establishment; and
- o There are many small establishments (though economic impacts are clouded by questions of ownership and operation for the retail establishment, the land occupied, and the tanks themselves).

Thus, the economic analysis has concentrated on the retail motor fuel sector. The other two sectors are addressed in less detail.

Methodology

The EPA Guidelines for performing regulatory impact analysis[1]/ recommend an analytical approach based on combined financial and market analysis, consisting of the following steps:

- o Segment the regulated industry into groups by relevant characteristics;
- o Perform baseline financial analysis on segments or on model plants;
- o Separate resource costs from transfers, such as taxes, that distribute the resource costs to parties other than the directly regulated community;

1/ EPA, Office of Policy Analysis, "Guidelines for Performing Regulatory Impact Analysis," EPA-230-01-84-003, December 1983.

- o Estimate effects of cost pass-throughs, including the assumption (and estimated likelihood) of no pass-through.

- o Where data allow, perform discounted cash flow analysis or return -on-investment analysis.

The results will estimate the impacts of regulatory costs on firm or facility revenue and profit for the segments of the regulated industry. This is the basic approach here.

According to the EPA guidelines, the general framework to be used is based on the static partial equilibrium model of supply and demand relationships in the affected markets. In this model, if regulations on suppliers increase the costs of providing a particular good or service, the market price of the affected good or service will increase and the amount provided to the market will decrease at any given price. The magnitude of the effects will depend on the relative sensitivity of supply and demand to changes in price (that is, the price elasticities of supply and demand). Economic effects (i.e., changes in profitability, plant closures, employment, inflation, capital availability, etc.) all flow from the changes in prices and quantities predicted by appropriate shifts in supply/demand schedules within the partial equilibrium framework. At a minimum it is helpful to examine the boundary conditions of perfectly elastic demand (full absorption) and perfectly inelastic demand (full pass-through), as shown in Exhibit 6.1.

For the three sectors addressed here, the boundary condition of full cost absorption is likely to be of most concern. This is the case because UST regulatory requirements will not affect any of these sectors uniformly. For the retail motor fuel segment, the following observations are pertinent:

- o UST regulatory costs are independent of quantity of gasoline pumped. Therefore, regulatory costs per gallon are likely to be much less for high volume stations, thus limiting the potential for pass-through.

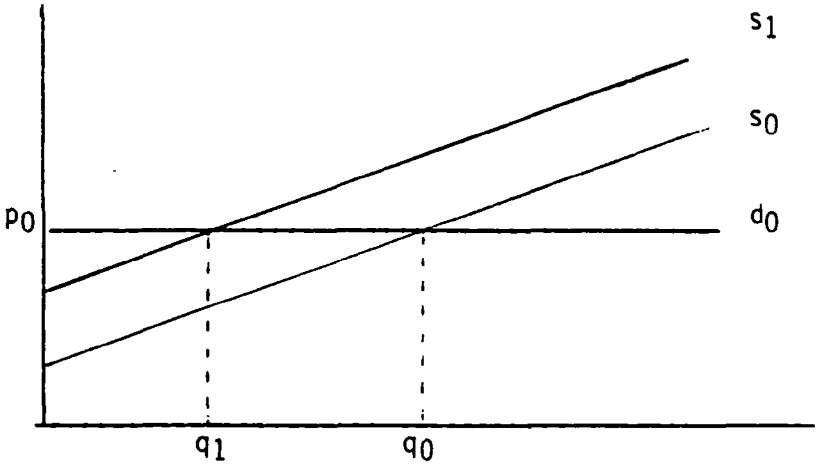
- o UST regulatory costs per station depend significantly on whether or not a release occurs and the costs of responding to it. These costs will not be spread evenly over stations, thus making it more likely that those who incur these costs will not be able to pass them through.[1/]

- o Some stations are much further along in release prevention/detection programs than others, thus potentially spreading the regulatory burden unevenly and therefore limiting the likelihood of pass-through.

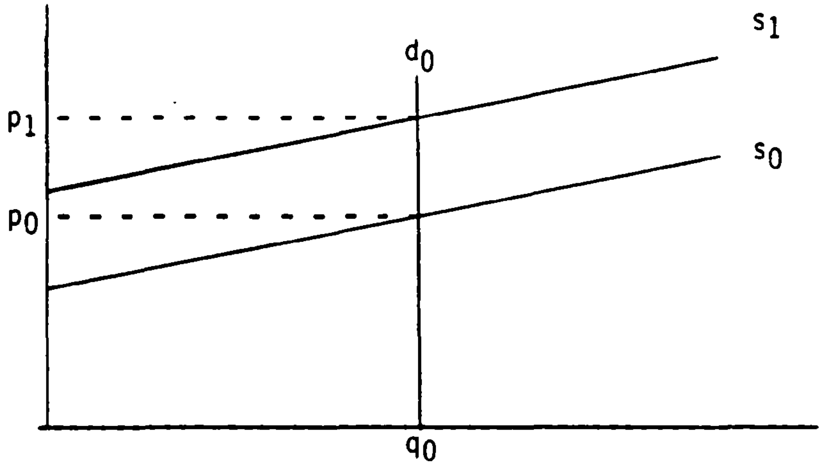
- o Although market demand for retail gasoline is relatively inelastic, demand at individual stations can be highly sensitive to price (i.e., there are few substitutes for gasoline, but there are many substitutes for the gasoline from an individual station).

[1/] This assumes that insurance is not available to cover corrective action costs. If such insurance were available, corrective action costs could be smoothed over output and therefore be treated as variable costs.

Exhibit 6.1
BOUNDARY CONDITIONS FOR ECONOMIC IMPACT ANALYSIS



a. Perfectly Elastic Demand (Full Absorption)



b. Perfectly Inelastic Demand (Full Pass-Through)

These reasons suggest that, particularly in the short run, the economic analysis for the retail motor fuels sector needs to focus on the scenarios of cost-absorption and its implications for potential exit from the industry. Similarly, for the other sectors, USTs are not spread uniformly through the affected industries, suggesting that full absorption is also the primary scenario of concern.

The importance of estimating potential exit attributable to regulatory alternatives suggests a need to predict expected exit in the absence of regulatory change. For the retail motor fuels segment, this is an important part of the baseline. It is necessary to distinguish these independently caused trends --notably, a continuous decrease in number of retail outlets, resulting in higher sales per station--from the added impacts of UST regulations. It should also be noted that two other environmental regulations, affecting used oil and vapor emissions controls, are also expected to be implemented during the early years of UST regulation. The costs of UST regulations, added to the costs of these two new regulations can be expected to affect the viability of facilities and firms in the motor fuel retailing industry, but not all business failures and/or closings during the early years of UST regulation can be attributed to UST regulations.

An additional factor which complicates the economic analysis for retail motor fuel is the complex pattern of ownership and operation for stations, tanks, and the land occupied. This makes it much more difficult to say precisely who bears the initial incidence of the regulatory burden and therefore muddies the issue of who bears the ultimate burden. This is explained in more detail in Section 6.B.

For the nonretail petroleum and chemical UST-using sectors, the key analytical tool used is the screening analysis. This screening analysis examines levels of regulatory costs relative to profit levels for UST-using industries (defined as four-digit SIC codes). It therefore serves as a rough indicator of the potential for economic dislocation. However, it is safe to conclude that these sectors will not undergo as much economic dislocation as retail motor fuel because:

- Only a fraction of establishments maintain USTs (thus suggesting the existence of substitutes for USTs);
- The average number of USTs per establishment is generally less than three; and
- USTs represent a smaller fraction of total costs for these industries than for retail motor fuel.

However, corrective action burdens may affect the viability of some firms (both large and small) because a firm cannot escape corrective action for existing releases by substituting away from USTs. Nonretail petroleum tanks are addressed in Section 6.C while chemical tanks are addressed in Section 6.D.

6.B IMPACTS ON UST-OWNING FIRMS IN THE RETAIL MOTOR FUEL MARKETING SECTOR

6.B.1 The Retail Motor Fuel Marketing Industry: Current Status and Future Trends

The retail motor fuel marketing industry is composed of a large number of firms that are widely diverse in their financial and operational characteristics. In 1984, the base year for this study, the industry was composed of almost 90,000 firms owning 193,000 retail motor fuel outlets and 43,000 firms operating retail motor fuel outlets that they leased from their owners. 1/

> The firms owning retail motor fuel outlets range in size from some of the largest corporations in the world to very small businesses with no reported payroll.
>
> The firms owning retail motor fuel outlets may own as few as one outlet or as many as several thousand outlets. Exhibit 6.2 illustrates the distribution of the number of outlets owned by firms engaged in the retail motor fuel marketing sector.
>
> Most firms owning more than one outlet engage in lines of business other than retail motor fuel marketing. Some engage in other types of retail operations, such as grocery sales or car washes. Many are involved in the wholesale marketing of gasoline or other petroleum products. The largest firms in this industry may be involved in all aspects of petroleum production, refining, distribution, and marketing. Such large firms are also often in other diverse lines of business (e.g., production and sale of chemicals, steel, etc.).

Retail motor fuel outlets vary substantially from one another. Some outlets (i.e., pumpers) specialize in low-cost, high-volume fuel sales and provide few if any ancillary services. Others (e.g., convenience stores) provide retail motor fuel primarily as an item to be purchased at the same time that customers purchase food, newspapers, or cigarettes. Other outlets specialize in providing a wide range of automobile-related services (e.g., repairs and routine maintenance).

Because of this diversity, there is no one data source that provides financial and operational information for firms or facilities engaged in retail motor fuel marketing as we have defined it. The Department of Commerce, for example, compiles data for firms deriving 50 percent or more of their revenues from the sale of motor fuels, but EPA could not use this definition because it does not include a substantial proportion of the UST-owning firms that sell retail motor fuels. Instead, EPA used information from government data sources, individual firms, and industry associations to construct the ownership and operational profile for retail motor fuel outlets shown in Exhibit 6.3. 1/ The types of owners of retail motor fuel outlets are defined below.

1/ <u>Lundberg Letter</u>, Vol. 13, No. 1, Nov. 1, 1985.

Exhibit 6.2
DISTRIBUTION OF THE NUMBER AND PERCENTAGES OF OUTLETS OWNED BY FIRMS OF VARIOUS SIZES ENGAGED IN RETAIL MOTOR FUEL MARKETING

Number of Outlets per Firm	Number of Firms in This Group	Total Number of Outlets Owned by Firms in This Group
1	80,304 (89.49) 1/	80,304 (41.61)
2-9	8,081 (9.01)	28,991 (15.02)
10-24	1,190 (1.33)	20,239 (10.49)
25-49	58 (0.06)	2,004 (1.04)
50-99	48 (0.05)	3,483 (1.80)
100-499	35 (0.04)	8,619 (4.47)
500-999	5 (0.01)	3,102 (1.61)
1,000+	18 (0.02)	46,255 (23.97)
TOTAL	89,738 2/	193,000

Source: Meridian Research, Inc. and Versar Inc., Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

1/ Numbers in parentheses are percentages of all firms or all outlets in this sector that are represented by this group.

2/ Columns may not total because of rounding; percentages are calculated for the rounded total.

Exhibit 6.3
OWNERSHIP AND OPERATION OF RETAIL MOTOR FUEL OUTLETS

Segment	Number of Firms	Number of Retail Outlets Owned and Operated	Number of Retail Outlets Owned and Leased	Total Number of Retail Outlets Owned
Refiners	27	9,964	36,817	46,781
Jobbers	8,766	25,333	20,713	46,046
Convenience Stores 1/	516	14,732	0	14,732
Independent Chains 2/	125	4,010	1,127	5,137
Open Dealers	80,304	80,304	0	80,304
TOTAL	89,738	134,343	58,657	193,000

Source: Meridian Research, Inc. and Versar Inc. Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

1/ Convenience store owners are defined to exclude jobbers.

2/ Independent chains are defined to exclude jobbers and convenience store owners.

- **Refiners** are large, vertically integrated oil companies owning refineries that produce petroleum products distributed through thousands of their wholesale and retail "branded" outlets. They include such companies as Amoco, Exxon, Chevron, Mobil, etc. The "semi-majors" are large, integrated oil companies that may own fewer refineries or supply fewer wholesaler retail outlets than the majors.

- **Jobbers** are primarily wholesalers of petroleum products who may also own retail service stations or convenience store outlets.

- **Convenience stores** are chains of retail stores that for our purposes exclude jobbers and include only those retail outlets that sell motor fuels.

- **Independent chain marketers** are owners of chains of retail motor fuel marketing outlets; they often sell "unbranded" or private brand petroleum products. For the purpose of this analysis, independent chain marketers are defined to exclude jobbers and convenience store owners.

- **Open dealers** both own and operate their gasoline marketing operations, usually at single-site locations. In many cases, open dealers are former lessee dealers who have bought their locations from the major oil companies or jobbers.

In addition to these owners, lessee dealers (also called independent dealers) operate outlets under lease arrangements, generally with refiners, jobbers, or independent chains.

Exhibit 6.4 shows the wide range of asset sizes among all of the types of firms owning retail motor fuel outlets. Although the vast majority of firms (93.6 percent) have less than $600,001 in assets, those firms with assets of $600,001 or more own the majority of retail outlets. The median firm has assets between $200,000 and $400,000, while the median outlet is owned by a firm with assets in the $600,000 to $1 million range. With the exception of the largest convenience store chain, all the firms with more than $1 billion in assets are refiners; all the firms with less than $200,000 in assets are open dealers. There is a relative absence of firms with assets in the $100 million to $1 billion range; this size range is too small for most refiners but too large for large jobbers or independent chains.

Exhibit 6.5 illustrates the distribution of net income to total assets ratios (commonly called the rate of return on assets) for all of the firms owning retail motor fuel outlets. This is the ratio used in our analysis (see Section 6.B.2) to characterize firms' financial health or profitability; the

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1/ Meridian Research, Inc. and Versar Inc., Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

Exhibit 6.4
DISTRIBUTION OF TOTAL ASSETS AMONG FIRMS
OWNING RETAIL MOTOR FUEL OUTLETS

Total Assets	Number of Firms in This Group	Number of Outlets Owned by Firms in This Group
0-$200,000	30,114 (33.56) 1/	30,114 (15.60)
$200,001-$400,000	33,410 (37.23)	36,705 (19.02)
$400,001-$600,000	20,478 (22.82)	21,684 (11.24)
$600,001-$1,000,000	3,567 (3.97)	14,268 (7.39)
$1,000,001-$10,000,000	2,063 (2.30)	28,722 (14.88)
$10,000,001-$100,000,000	76 (0.08)	9,572 (4.96)
$100,000,001-$1,000,000,000	4 (0)	2,562 (1.33)
$1,000,000,000+	27 (0.03)	49,371 (25.58)
TOTAL	89,738 2/	193,000

Source: Meridian Research, Inc. and Versar Inc., Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

1/ Numbers in parentheses are percentages of all outlets or all firms in this sector represented by the firms in this asset group.

2/ Columns may not total because of rounding; percentages are calculated for the rounded total.

Exhibit 6.5
DISTRIBUTION OF NET INCOME TO TOTAL ASSETS
RATIOS AMONG FIRMS OWNING RETAIL MOTOR
FUEL OUTLETS

Ratio of Net Income to Total Assets	Number of Firms in This Group	Number of Outlets Owned by Firms in This Group
Less than 0	1 (0) [1/]	185 (0.10)
0-0.02	30,573 (34.07)	48,801 (25.29)
0.02-0.04	1,540 (1.72)	25,891 (13.42)
0.04-0.06	6,941 (7.73)	45,840 (23.75)
0.06-0.08	30,590 (34.09)	42,054 (21.79)
0.08+	20,094 (22.39)	30,225 (15.66)
TOTAL	89,738 [2/]	193,000

Source: Meridian Research, Inc. and Versar Inc., Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

[1/] Numbers in parentheses are percentages of the total population of outlets or firms in this net income to total assets group.

[2/] Columns may not total because of rounding; percentages are calculated for the rounded total.

lower a firm's return on assets, the greater its likelihood of failing or of being in severe financial distress. The median net income to total assets ratio for these firms is between 0.06 and 0.08 (i.e., between 6 percent and 8 percent), a fairly typical return on assets for U.S. firms that are not engaged in banking or financial services. Such a value shows that firms in the retail motor fuel marketing sector are, on average, neither more nor less profitable than firms engaged in most other lines of business.

Most of the net income to total assets ratio categories include both large and small firms: although a large convenience store chain is the only firm represented in the negative (i.e., less than 0) return on assets category, the second lowest category of return on assets (0 to 0.02) includes both single-outlet open dealers and the Texaco Corporation. Firms in the highest rate of return category include both Exxon and single-outlet open dealers.

Small Businesses in the Retail Motor Fuel Marketing Industry

Exhibit 6.6 shows the numbers of small businesses, by industry segment, that will be affected by this regulation. For the purpose of this analysis, small businesses are defined using the Small Business Administration's definition for this industry sector: firms with less than $4.6 million in annual sales. 1/ In 1984, small businesses meeting this definition either owned or operated more than 75 percent of the 193,000 retail motor fuel outlets in the United States.

Of this number, open dealers were estimated to own approximately 80,000, or 42 percent, of all retail motor fuel outlets. Open dealer firms vary widely in size and age; some open dealers have new outlets and over $500,000 in assets, while others have 30-year-old outlets and only $42,000 in assets. EPA estimates that the typical (the statistical median) open dealer has $90,000 in net worth, $210,000 in assets, and $14,000 in annual after-tax profits. Such a typical open dealer firm is thus a business earning a reasonable return on investment and having a reasonable expectation of continuing in business.

In addition to open dealers, small business owners in the retail motor fuel marketing sector include owners of small chains of retail outlets. It is common for owners of small chains to own two or three retail outlets and also to act as wholesale suppliers for several open dealers. (This business pattern is particularly common in rural areas.) It is also common for firms in this sector to own a chain of several convenience stores, some of which do not sell gasoline. For such small convenience store chains, gasoline sales are not generally the primary line of business. EPA estimates that there were 3,700 such chains owning 8,200 retail motor fuel outlets in 1984.

The Agency estimates that 59,000 retail motor fuel outlets are operated by lessee dealers, whose outlets thus represent 30 percent of all retail motor fuel outlets. The majority of these lessee-dealer-operated outlets are owned

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1/ Federal Register, Vol. 49, No. 28, p. 5032, February 9, 1984.

Exhibit 6.6
NUMBER OF FIRMS AND OUTLETS POTENTIALLY AFFECTED BY UST REGULATION, BY SIZE CATEGORY AND SEGMENT

Segment	Number of Firms	Number of Outlets Owned or Leased
	Small Businesses 1/	
Small Business Owners		
Small Jobbers	3,296	6,591
Small Convenience Stores	402	1,608
Open Dealers	80,304	80,304
Small Business Operators		
Lessees	43,131	58,657
Total Small Businesses (Owners and Operators)	127,133	147,159
	Large Businesses	
Large Business Owners		
Refiners	27	46,781
Large Jobbers	5,470	39,455
Large Convenience Stores	114	13,124
Independent Chains	125	5,137
Total Large Businesses	5,736	104,497

Source: Meridian Research, Inc. and Versar Inc., Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

1/ Defined as firms with less than $4.6 million in annual sales.

by large, vertically integrated firms that engage in petroleum production, refining, and marketing, but many are owned by independent marketers who own chains consisting of between 2 and 100 retail motor fuel outlets. The outlets operated by lessee dealers range in characteristics from some of the most modern and efficient outlets in the country to some of the most financially marginal operations in the retail motor fuel marketing sector. EPA estimates that the typical (statistical median) single-station lessee dealer is a firm with $82,000 in assets, $62,000 in net worth, and $6,000 a year in after-tax profits; the typical lessee dealer is thus a very small firm, but one which nevertheless has reasonable profits for the size of the business and a reasonable expectation of continuing in business.

The impacts of UST regulation will differ for different segments of the small-business portion of this industry. For example, open dealers, who both own and operate an outlet, will have to meet all of the costs of UST regulations. However, for lessee dealers the situation is more complex because, although the terms and conditions of leases vary widely, the most common arrangement makes the lessee dealer responsible for "sounding the alarm," i.e., for operating whatever leak detection and inventory control systems have been agreed to by both the owner and the lessee, but not for maintaining or replacing tanks or paying for corrective action. 1/ However, EPA is aware that some lessors are attempting to alter these arrangements to increase the responsibilities of lessees by, for example, holding the lessee responsible for releases or requiring the lessee to buy the tanks. In this Regulatory Impact Analysis, EPA has assumed that the terms of traditional lease arrangements will prevail, and the analysis therefore does not assess the impacts of any changes in lease terms on lessee dealers. However, the analysis does consider cases in which severe economic impacts could cause the owner of a leased outlet to close the outlet and thus force the lessee dealer out of business.

Although the typical open dealer and lessee dealer are sound businesses, there are marginal firms in both categories. A marginal firm is defined as one that is making very low profits or that has an aging outlet and cannot afford to invest any substantial amount of money in this outlet. Marginal firms are likely to fail or close their outlets in the event of significant regulatory expenditures; however, many of these firms would also leave the industry even in the absence of regulatory costs.

Current Trends

Three sets of long-term annual data provide information on current trends in the number of retail motor fuel outlets. These three data series, and the trends they illustrate, are described below.

- U.S. Census Bureau Service Station Population: this time series estimates the number of service stations, defined as facilities receiving more than 50 percent of their revenues from sales of gasoline and related products. This definition does not include a substantial number of retail motor fuel outlets that receive sales from other sources. Census data show that, from 1974 to 1984, the number of service stations declined from 196,000 to 132,000, a decline of

1/ Notes of meeting with the Service Station Dealers of America, 1986.

33 percent over 11 years, for an average annual rate of decline of 3.7 percent per year. 1/

- American Petroleum Institute Reports: These cover deactivations and openings of retail motor fuel outlets reported by 30 member companies; this time series does not, however, provide data on the total number of facilities owned by API member companies. This source defines deactivation as the closing of an outlet (including removal of the outlet's equipment) for which no reopening is contemplated. For the period 1974 to 1984, this data series shows that refiners deactivated 48,852 outlets and opened 2,973 outlets, for a net decline in refiner-owned outlets of 45,879 outlets. This net decline in refiner-owned outlets is equal to 72 percent of the total decline in service stations reported by the Bureau of Census source, which suggests that the decline in outlets may be explained in large part by refiner closings of marginal lessee operations. 2/

- The Annual Dollars-Per-Day-Survey of Convenience Stores: This survey provides estimates of the number of convenience stores selling gasoline. From 1974 to 1984, the Dollars-Per-Day Survey reports that the number of convenience stores selling gasoline has risen from 3,520 to 22,475, an average annual growth rate of 20 percent per year. 3/

These time series enable us to conclude that the total number of retail motor fuel outlets is declining, that convenience stores are increasing both in numbers and share of all retail motor fuel outlets, and that the closure of outlets is as important a phenomenon for refiners as for smaller businesses.

Future Trends

For our purposes, the data series described above do not provide a basis for projecting future trends. For example, except for refiners, the number of outlets that actually exit, as against the net decline or growth in outlets, is not reported. Further, the data are not segmented in a way that can be applied directly to the categorization and representative firm methodology for this analysis of the industry.

The annual exit rates for outlets owned by small and large firms were produced in the following manner:

1/ U.S. Department of Commerce, Franchising in the Economy 1983-1985, January 1985; cited in National Petroleum News, 1986 Factbook.

2/ American Petroleum Institute, New Construction Report, May 1984; cited in National Petroleum News, 1986 Factbook.

3/ John F. Roscoe, 14th Annual Dollars-Per-Day Survey, March 1985; cited in National Petroleum News, 1986 Factbook.

- Based on the time series data described above, we estimated that, in 1984, 4,200 retail motor fuel outlets owned by firms other than refiners exited the industry. (Refiner-owned outlets were excluded from the economic impact analysis because we assumed that the costs of these regulations would play only a minor role in the decisions of refiners to close their outlets.)

- We attributed outlet closures to representative firms on the basis of the number of firms they represent and their rate of return on assets, because firms with higher rates of return will probably close fewer outlets than firms with lower rates of return.

- We devised a system for allocating the estimated 1984 closures among representative firms by assessing the effects on rates of return that the costs of tank replacement would have on these firms. We assumed that 4.7 percent of all tanks would have to be replaced, 1/ at a cost of $20,000 per tank. Although there are many types of costs that could cause a firm to close its outlets, it is critical for this analysis to allocate some closures to the fact that the firm was required to replace tanks at such outlets; unless this methodology is used, it is difficult to assess the impacts associated with the increase in tank replacement caused by regulatory requirements.

Exhibit 6.7 shows the annual exit rate of outlets owned by small businesses and large businesses other than refiners in 1984, and the projected percentages of existing retail motor fuel outlets in each category that will exit 5, 10, or 15 years in the future. It should be noted that these exit trends do not attribute any exit to corrective action expenditures. All exit due to corrective action is attributed to EPA corrective action requirements.

6.B.2. Methodology and Assumptions

Impacts

The economic impact analysis was performed using an affordability model, 2/ which provided estimates for the following economic impacts:

- The current industry baseline ratio of net (i.e., after-tax) income to total assets (i.e., the rate of return on assets) for each representative firm, and the changes that would occur in this ratio as a result of the imposition of various levels and types of regulatory costs.

1/ Based on SCI estimates using UST Model results; analysis of the "base case."

2/ Meridian Research, Inc. and Versar Inc., Documentation for the Affordability Model, Draft Report, March 1987; see Appendix C: Methodology Used to Estimate Economic Impacts, for a summary of the structure of the affordability model.

Exhibit 6.7
PROJECTED EXIT OF EXISTING RETAIL MOTOR FUEL OUTLETS

Ownership	Annual Exit Rate in 1984	Projected Exit as a Percentage of Current Outlets Through Year 5	Projected Exit as a Percentage of Current Outlets Through Year 10	Projected Exit as a Percentage of Current Outlets Through Year 15
Small Business 1/	4.06%	19%	28%	36%
Large Business Other Than Refiners	1.00%	5%	10%	14%

Source: Meridian Research, Inc. and Versar Inc., Documentation for the Affordability Model, Draft Report, March 1987.

1/ Defined as firms with less than $4.6 million in sales.

- The percentage of outlets voluntarily exiting the industry. "Voluntary exit" is defined as an owner or operator's choice to close one or more outlets. It includes both baseline exit (defined as exit unrelated to the imposition of new regulatory costs) and the exit of outlets owned by firms that decide that paying expected regulatory compliance costs would decrease profits to levels lower than acceptable. Owners of outlets with tanks that have releases and thus require corrective action do not have the option of voluntarily closing their outlets. These outlets either fail, if the firms owning them fail, or remain in business.

- The percentage of failing firms and the percentage of failed outlets (the percentage of all outlets owned by the failed firms). It is assumed that all firms that incur regulatory costs will attempt to meet them, and that no firm incurring a corrective action may voluntarily close any of its outlets. The latter assumption is not descriptive of the situation for large firms; thus, separate analyses are required for small and large firms.

- The percentage of firms in severe financial distress (defined as firms that do not file for bankruptcy but that exhibit signs of severe financial distress, such as restructuring their debt or missing loan payments).

In the small firm analysis, the overall percentage of outlets surviving at a given point in time (i.e., at the end of Year 5, Year 10, or Year 15 after the promulgation of tank technical requirements) was calculated based on both the percentage of outlets voluntarily exiting and the percentage of outlets closing because the firm had failed.

Affordability Model

The affordability model contains financial (e.g., net income, total assets, etc.) and operating (e.g., number of outlets owned, number of outlets operated, etc.) data for 69 firms taken to represent the approximately 90,000 firms that own and the 43,000 firms that operate and lease 193,000 retail motor fuel outlets. 1/

Exhibit 6.8 shows how the affordability model can be used to perform the economic impact analysis of UST regulatory options and scenarios. First, the initial net income and total assets of owners of representative firms are reduced to reflect the impact of various levels and types of regulatory costs. Regulatory costs are divided into capital and other costs; capital costs are treated differently for tax reasons (e.g., the investment tax credit is applied). The model has a scalar to adjust net income to take account of revenue increases. The model also incorporates the probability that USTs owned by firms will experience release incidents requiring corrective action and thus that firms will incur the costs associated with such incidents (i.e., for assessment, cleanup, tank upgrading, tank closure, tank replacement) and

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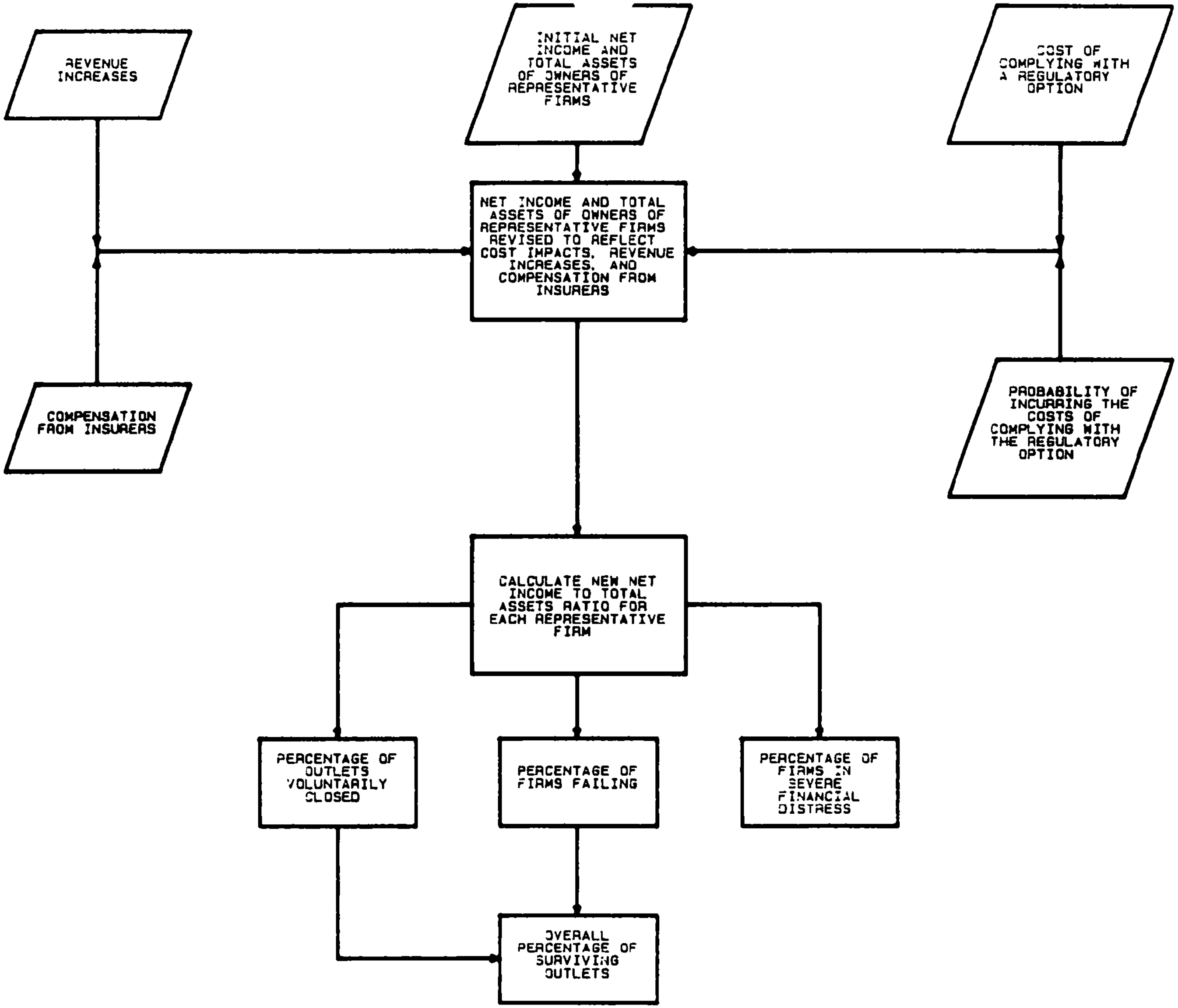
1/ Meridian Research, Inc. and Versar Inc., Financial Responsibility for Underground Storage Tank Releases: Financial Profile of the Retail Motor Fuel Marketing Industry Sector, Draft Report, March 1987.

USE OF THE AFFORDABILITY MODEL TO PERFORM ECONOMIC ANALYSIS OF THE IMPACTS OF REGULATORY OPTIONS



SOURCE: MERIDIAN RESEARCH, INC. AND VERSAR INC., AFFORDABILITY MODEL DOCUMENTATION, 1987.

accounts for payments from insurers to cover these costs. The model assumes that those firms that are able to pass financial tests (tests that require a firm to have a certain ratio of net income to total assets and loan size to total assets) can borrow to pay the costs of corrective action, tank replacement, and upgrading. The magnitude of the UST financial responsibility that will be left unfunded is determined by the percentage of failing firms, the number of outlets owned by these firms, and the amount of corrective action costs these firms are predicted to incur.

The percentage of firms failing was estimated based on the results of a study that used empirical data that established a relationship between ratios of net income to total assets for firms in various asset classes and the probability that firms in these classes would fail. 1/ These data show that firms whose net income to total assets ratio is below -.30 almost always fail. The model assigns appropriate failure probabilities to firms with higher ratios of net income to total assets. Severe financial distress rates are based on the same empirical data. These data show that firms whose net income to total assets ratios fall in the range of -.04 to -.30 are likely to experience financial distress even if they do not fail.

Assumptions

The assumptions used in this analysis are classified into two groups:

- Key assumptions
- Additional assumptions.

Key assumptions are those most critical in defining the general limits of the analysis and thus of the study's results. The six key assumptions are that:

- No steel tanks are cathodically protected. Eighty-nine percent of tanks are bare steel and 11 percent are fiberglass.
- No insurance or other form of private risk pooling will be available for UST releases.
- Leaks will be discovered with the probabilities developed by SCI using the UST Model. (Option II, for example, predicts that 26 percent of tanks will have high-cost releases within 5 years and that 33 percent of tanks will have low-cost releases within 5 years).
- The National Leaking UST Trust Fund will not alleviate the economic impact of corrective action costs.
- No State UST Funds will be used to pay corrective action costs.

1/ Meridian Research, Inc. and Versar Inc., Documentation for the Affordability Model, Draft Report, March 1987.

- With the beginning of each new year, each surviving firm's annual net income and net worth will revert to their original values.

Exhibit 6.9 describes the effect that each key assumption has on the results of the analysis and evaluates the strength of each effect.

The additional assumptions underlying the economic impact analysis are divided into three categories:

- Economic and financial
- Technical
- Those related to choice of compliance method.

The additional assumptions are presented, by category, in Exhibits 6.10 through 6.13. Unlike the key assumptions, these additional assumptions do not define the limits of the analysis; instead, they present data, describe data sources, and illustrate how parts of the analysis work.

6.B.3. Impact Analyses

This section describes the results of the economic impact analyses performed for the regulatory options being considered. First, it analyzes the impacts of the costs being considered on the typical open dealer firm. Second, the impacts of regulatory costs on small firms are assessed, assuming both that there will not be a revenue increase and that there will be a revenue increase. Finally, large-firm impacts are evaluated assuming both that there will and will not be revenue increases. Small-firm impacts are expressed in terms of the percentage of outlets owned by small firms that will survive, while large-firm impacts are presented in terms of the impacts of regulatory expenditures on the ratios of net income to total assets per outlet. A separate impact analysis is performed for lessee dealer firms. Impacts on these firms are dependent on the economic impacts on large firms.

Analysis of Impacts on the Median Open Dealer Firm

This economic impact assessment analyzes the costs likely to be imposed on UST-owning firms under each of the regulatory options under consideration. The model uses 69 representative firms to represent the 133,000 firms in the industry. (See Appendix D for further discussion of represented firms). The most important results of the analysis can be seen best by examining the impacts of selected regulatory scenarios on one representative firm in a single year. The one firm chosen for this purpose is the median open dealer, defined as a firm that owns and operates one retail outlet and that has the median level of net income, total assets, and net worth for open dealer firms. This firm is assumed to represent 10,000 of the 80,000 firms in the open dealer segment of the industry, and can be considered typical of the firms in the open dealer segment because it has median values for financial characteristics.

Exhibit 6.9
KEY ASSUMPTIONS AND THEIR EFFECTS ON THE RESULTS OF THE ANALYSIS

Assumption	Effect of Assumption on Results of the Analysis
No steel tanks are cathodically protected. Eighty-nine percent of tanks are bare steel and 11 percent are fiberglass.	Slightly overestimates the impact of corrective action and other regulatory compliance costs. In fact, 13 percent of all steel tanks are cathodically protected.
No insurance or other form of private risk pooling will be available for UST releases.	Overestimates the impact of corrective action costs because insurance or other forms of private risk pooling will cover some corrective action costs; however, this overestimate is not large because (1) tank upgrading and replacement costs will not be covered, and (2) many small firms cannot obtain insurance.
Releases will occur with the probabilities developed by SCI using the UST Model (Option II, for example, predicts that 26 percent of tanks will have high cost releases within 5 years and that 33 percent tanks will have low cost releases within 5 years.)	Section 4 discusses the assumptions used as a basis for determining the probabilities of corrective action. If the estimated probabilities are, for example, too low, the numbers of corrective action incidents in this analysis are understated, and thus their economic impacts are also understated.
The National Leaking UST Trust Fund will not alleviate the economic impact of corrective action costs.	Slightly overestimates the impact of corrective action costs on firms. With the passage of SARA, a national UST Trust Fund in the amount of $500 million has been authorized, but the Fund cannot, in most cases, be used to cover the corrective action costs of solvent firms that lack financial assurance at the required levels, and the Fund is not large enough to significantly change the economic impacts of corrective action costs.
State UST funds will not be used to pay corrective action costs.	The degree to which the impacts are overestimated depends on: how actual funds are designed, their adequacy in covering the corrective actions that occur, and the number of States implementing them. Impacts would be seriously overestimated if many States implement State funds that provide adequate coverage for releases, and include credit assistance for tank closure and replacement.

Exhibit 6.9 (Continued)

Assumption	Effect of Assumption on Results of the Analysis
With the beginning of each new year, each surviving firm's annual net income and net worth are assumed to revert to their original values.	Underestimates economic impacts. The percentage of surviving outlets is slightly overestimated for small firms; impacts on the profitability of large firms are seriously underestimated.

Exhibit 6.10
ADDITIONAL ASSUMPTIONS (ECONOMIC AND FINANCIAL)

- Loan availability

  - In the impact analyses, it is assumed that loans are available to firms that meet certain financial criteria. 1/

  - In the median open dealer analysis, it is assumed that the median open dealer is not able to obtain a loan.

- A firm's net income and the value of its total assets determine its financial condition.

  The underlying assumptions are as follows:

  - A firm's net income for a year is its after-tax profits.

  - The ratio of net income to total assets determines the financial condition of a firm. If a firm's ratio is less than -0.3, it is assumed to fail. If its ratio is -0.3 or greater, a probability of failure is assigned to the firm. The higher the ratio, the lower the probability of failure.

- Costs are financed either internally, first through net income and then through asset sales, or externally through a loan. A firm may sell assets only to cover those costs that cannot be met by its net income.

- Value of a firm's total assets

  - The value of a firm's total assets will decrease by the value of the assets sold when assets are sold to cover costs.

  - A firm's value of total assets will remain constant unless assets are sold; the value of firms' total assets are assumed to revert to their original value at the beginning of each year.

Source: Meridian Research, Inc. and Versar Inc., Documentation for the Affordability Model, Draft Report, March 1987.

1/ The financial criteria are based on the notes of a meeting with First Virginia Bank, 1986.

Exhibit 6.11
ADDITIONAL ASSUMPTIONS (TECHNICAL)

- All firms have 3.5 tanks at each outlet.
- Releases are detected only as a result of a tank test or another method of leak detection/monitoring.
- The corrective action, 1/ tank upgrade, 2/ and leak detection costs 3/ used in the analysis are based on the UST Model.

  Average site-by-site corrective action costs, including leak verification costs of $4,000 but excluding costs for tank replacement, are:

  - $23,100 for a non-plume release
  - $37,200 for corrective action to clean up the floating plume only for plumes of less than 25 square meters, and $63,200 for corrective action to clean up both the floating and dispersed plumes for plumes of less than 25 square meters.
  - $127,700 for a plume release with an area of greater than 25 square meters.

  -- Costs for the upgrading of one tank are $3,050

  -- Costs for the mandatory replacement of one tank 4/ are:

  - Closure: $12,500
  - Tank replacement: either $20,000 for a cathodically protected tank, or $23,000 for a protected tank with a liner.
  - Testing of the tank one year later: cost as listed below.

- Leak detection/monitoring costs are based on those provided in the Cost Effectiveness Analysis and are as follows:

  - Tank test: $500/tank.

1/ See: Section 4.D.3.

2/ See: Section 4.C.2.

3/ See: Section 4.B.2.b.

4/ The costs for mandatory tank replacement are based on engineering estimates.

Exhibit 6.11 (Continued)

Monthly vapor well monitoring: initial capital cost of $1,500 per facility, plus $900 in annual costs thereafter.

Inventory control costs are assumed to be $0 because inventory control is current industry practice.

- The probabilities that corrective actions will occur and their severity were taken from the Cost Effectiveness Analysis.

  Specific assumptions are as follows:
  Yearly probabilities of plume releases of less than 25 square meters, plume releases of greater than 25 square meters, and non-plume releases were computed for each of the options.

  - The 15 probabilities provided by SCI using the UST model 1/ for each combination of option and release type were arranged into 3 groups: (1) the probabilities for years 1-5; (2) the probabilities for years 6-10; and (3) the probabilities for years 11-15.

  - Each group's 5 annual probabilities were totaled. An average annual probability was computed by dividing this total by 5. This average was used as the probability of corrective action for each of the years defined by the group.

  Probabilities for years 1-5, 6-10, and 11-15 were determined for releases with corrective action costs of over $50,000, (called high cost release events) and under $50,000 (called low cost release events), using the following assumptions; 2/

  - All plume releases of greater than 25 square meters cost more than $50,000.

  - Sixty percent of plume releases of less than 25 square meters involve cleanup of both the floating and dispersed plume, and have costs of greater than $50,000.

  - Forty percent of plume releases of less than 25 square meters involve cleanup of the floating plume only, and have costs of less than $50,000.

  - All non-plume releases have costs of less than $50,000.

1/ Based on SCI estimates, using UST Model.

2/ Meridian Research, Inc. and Versar Inc., based on SCI estimates using the UST Model.

Exhibit 6.11 (Continued)

- Corrective action costs for high-cost and low-cost release events were determined for each option by the weighted average of costs for plume release of greater than 25 square meters, plume release of less than 25 square meters, and non-plume releases. The resulting weighted costs for each option are presented in Exhibit 6.12.

- Tanks are assumed to be replaced based on the UST Model estimates for each option. These tank replacement rates are presented in Exhibit 6.12.

- Mandatory tank retirement or upgrading is assumed to take place at a rate of 6.4 percent of tanks per year for Options II and V, and at a rate of 3 percent of tanks per year for Option IV.

Exhibit 6.12
COSTS AND PROBABILITIES OF CORRECTIVE ACTION EVENTS AND THE PROBABILITY THAT A TANK IS REPLACED AS A RESULT OF A CORRECTIVE ACTION EVENT

5-Year Interval	High-Cost Release Event: Corrective Action Cost	High-Cost Release Event: Probability of Event	Low-Cost Release Event: Corrective Action Cost	Low-Cost Release Event: Probability of Event	Probability That a Tank is Replaced As a Result of a Corrective Action Event
Option I					
Each of Years 1-5	$108,149	0.0590	$30,650	0.0600	0.055
Each of Years 6-10	107,356	0.0308	28,512	0.0452	0.023
Each of Years 11-15	108,375	0.0286	28,228	0.0424	0.030
Option II					
Each of Years 1-5	$102,431	0.0520	$30,650	0.0660	0.054
Each of Years 6-10	101,836	0.0176	28,104	0.0344	0.018
Each of Years 11-15	104,000	0.0100	28,133	0.0180	0.011
Option III					
Each of Years 1-5	$108,767	0.0582	$30,624	0.0578	0.055
Each of Years 6-10	108,533	0.0300	28,493	0.0420	0.024
Each of Years 11-15	108,872	0.0268	28,318	0.0382	0.030
Option IV					
Each of Years 1-5	$103,583	0.0522	$30,626	0.0638	0.053
Each of Years 6-10	104,299	0.0182	28,763	0.0288	0.015
Each of Years 11-15	103,676	0.0168	28,763	0.0272	0.020
Option V					
Each of Years 1-5	$98,845	0.0496	$30,802	0.0694	0.056
Each of Years 6-10	98,989	0.0152	28,228	0.0318	0.016
Each of Years 11-15	63,200	0.0004	28,763	0.0016	0.002

Source: Meridian Research, Inc. and Versar Inc., based on SCI estimates using the UST Model.

Exhibit 6.13
ADDITIONAL ASSUMPTIONS (RELATED TO CHOICE OF METHOD OF COMPLIANCE)

- If an option allows for a choice between replacing and upgrading a tank, it is assumed that firms will choose to upgrade.
- If an option allows for a choice in the method of leak detection/monitoring used, the choices assumed in Section 4.

The analysis shows that two events largely determine the magnitude of the economic impacts associated with Options I-V: corrective action and replacement of a tank. Exhibit 6.14 compares the economic impact on the median open dealer of two different types of corrective action events, a plume release and a non-plume release, and of replacing a tank. The costs of a plume release are the average costs of responding to a release having a plume of more than 25 square meters. (Although the scenario depicted in Exhibit 6.14 involves a corrective action that requires replacing a tank, the economic impact analysis assumes that only 60 percent of corrective actions will require tank replacement.) Exhibit 6.14 shows that:

- Having to perform corrective action for a non-plume release forces the median open dealer firm into a "severe financial distress" condition. Firms in this condition have an increased probability of failure, have difficulty in meeting existing loan or credit obligations, and consider leaving the business.

- Having to perform a corrective action for a plume release causes the median open dealer firm to fail even before the leaking tank is closed and replaced.

- Having to replace one tank also forces the median firm into a condition of severe financial distress. (Having to replace 3 tanks at once would bankrupt the firm.)

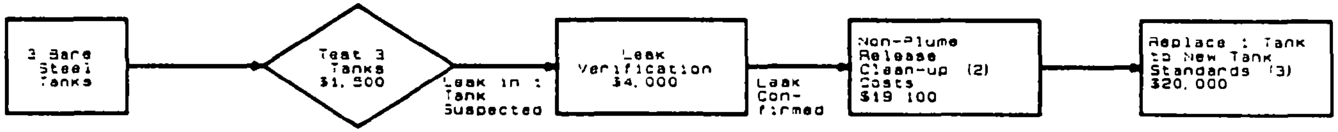
The costs of these events are significant compared with the net worth and profits of the median open dealer firm. The corrective action expenditures required to clean up a plume release exceed the net worth of such firms and are equal to 10 years' worth of their profits. Replacement of one tank has a cost equal to more than one-third of the net worth of the median open dealer, or more than 2 years of such a dealer's profits. (The impact of mandatory tank upgrading as permitted under Option II has a relatively small impact on the financial condition of the median open dealer. The $3,050 cost of cathodically protecting a tank would leave such a firm in good financial condition, with a return on assets of 5.4 percent in the year in which this cost is incurred.)

Costs of the magnitude of those for tank closure and replacement present two problems for the median open dealer. First, because of limited access to credit, the median open dealer may be unable to raise the funds to pay for such expenditures. Second, in a business that typically has a planning horizon of less than 5 years, an expense large enough to absorb 2-10 years of profits could easily persuade the owner to leave the industry.

Although it may initially seem odd that a firm confronted with corrective action or tank replacement costs will not be able to raise the necessary capital, especially since less capital is required for these expenses than was required to start the business in the first place, there are important differences between regulatory expenditures (e.g., replacing all tanks in one year) and investing in a business. First, a new business has substantial resaleable assets that can be used as collateral for a loan, while a corrective action cleanup or replacement of a tank system cannot be used to provide security for a loan. Second, although the business can be expected to provide a regular

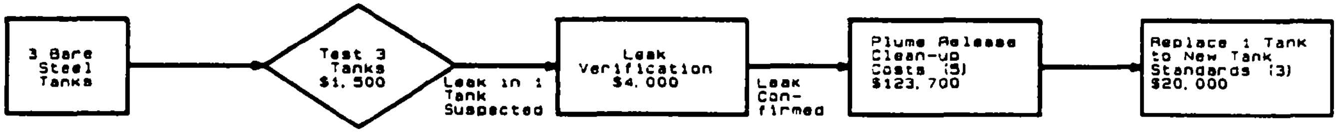
Exhib. [illegible].14
THREE SOURCES OF SEVERE FINANCIAL HARDSHIP FOR THE MEDIAN OPEN DEALER (1)

Source #1: A Non-plume Release



Impacts on Firm: (4)					
Net Income	$14,000	$12,720	$9,320	-$8,140	-$28,400
Net Income/Assets	6.67%	6.06%	4.44%	-4.03%	-15.64%
Financial Condition	Good	Good	Fair	Severe Financial Distress	Severe Financial Distress

Source #2: A Plume Release



Impacts on Firm: (4)					
Net Income	$14,000	$12,720	$9,320	-$112,740	Failure
Net Income/Assets	6.67%	6.06%	4.44%	-115.91%	
Financial Condition	Good	Good	Fair	Failure	

Source: Meridian Research, Inc. and Versar Inc., using the affordability model, 1987.

(1) The median open dealer is the owner of a single outlet who possesses $14,000 in net income, $210,000 in total assets, and $90,000 in net worth. These median financial characteristics were determined from survey data compiled by the Service Station Dealers of America (SSDA) and from the FINSTAT data base provided by the Small Business Administration (SBA).

(2) The non-plume release clean-up cost is a weighted average of the corrective action costs specified by EPA. Each corrective action cost is weighted by the probability of its occurrence, as specified by EPA. The specific calculation is as follows: (0.2 x $2,700) + (0.8 x $23,200) = $19,100

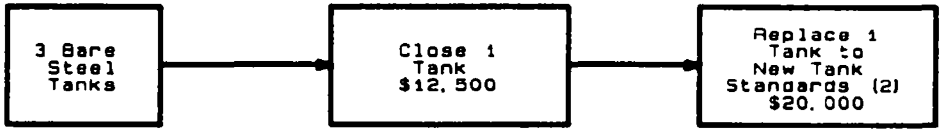
(3) Protected single-walled tank system with improved line leak detectors, capital cost of $7,000, installation cost of $13,000. This is the least expensive type of replacement tank system and is allowed under Options I and II.

(4) Assuming that there are no price increases; that net income calculations include the effect of taxes; and that the firm's net income, total assets, and net worth return to their original levels with the beginning of each new year.

(5) The plume release clean-up cost is a weighted average of the corrective action costs specified by EPA. Each corrective action cost is weighted by the probability of its occurrence, as specified by EPA. The specific calculation is as follows: (0.6 x $56,200) + (0.1 x $131,200) + (0.1 x $206,200) + (0.2 x $281,200) = $123,700.

Exhibit 6.14 (continued)
THREE SOURCES OF SEVERE FINANCIAL HARDSHIP FOR THE MEDIAN OPEN DEALER (1)

Source #3: The Replacement of One Tank



Impacts on Firm: (3)			
Net Income	$14,000	$3,370	-$16,300
Net Income/Assets	6.67%	1.60%	-8.42%
Financial Condition	Good	Fair	Severe Financial Distress

Source: Meridian Research, Inc. and Versar Inc., using the affordability model, 1987.

(1) The median dealer is the owner of a single outlet who possesses $14,000 in net income, $210,000 in total assets, and $90,000 in net worth. These median financial characteristics were determined from survey data compiled by the Service Station Dealers of America (SSDA) and from the FINSTAT data base provided by the Small Business Administration (SBA).

(2) Protected single-walled tank system with improved line leak detectors, capital cost of $7,000; installation cost of $13,000. This is the least expensive type of replacement tank system, and is allowed under Options I and II.

(3) Assuming that there are no price increases; that net income calculations include the effect of taxes; and that the firm's net income, total assets, and net worth return to their original levels with the beginning of each new year.

income, corrective action and tank replacement expenditures provide no new income. A roughly parallel comparison would be the difference between buying a new car, which represents a valuable asset with an expected lifetime of more than 10 years, and paying to rebuild the engine of an 8-year-old car, which might easily cost more than the potential sales value of the car. Additionally, although low-cost financing might be available for a new car, because the car itself can be used as collateral for the loan, such financing would certainly not be available to pay for the old car's engine job.

Analysis of the Impacts of Regulatory Options on Outlets Owned by Small Firms, Assuming No Revenue Increase

This economic impact analysis assesses the percentage of outlets owned by small firms that will exit the retail motor fuel marketing sector and identifies the factors responsible for these exits. The following section presents the cumulative percentage of small-firm-owned outlets surviving at the close of years 5, 10, and 15 after implementation of any of the UST regulatory options under consideration.

Some retail outlets in the motor fuel marketing sector will exit the industry even without the imposition of regulatory costs on their owners; exits occurring in the absence of regulatory costs are termed "natural" exits. Natural exits were estimated by dividing the number of exits predicted by past industry exit trends, which were assumed to continue for the next 15 years, by the number of retail outlets owned by small firms (defined as firms with less than $4.6 million in assets) now in the industry.

To determine the percentage of total exits attributable to a given regulatory option, the percentage of natural exits was subtracted from the percentage of exits predicted to occur under that option. The difference between these percentages was then attributed to the impact of regulatory costs. Exits caused by regulatory costs are divided into two categories:

- Exits attributed to tank replacement--this category of exit includes all exits (above the percentage of natural exits) attributable to the impact of the costs of leak detection, mandatory tank upgrading, replacement of tanks that cannot be repaired after a release, or mandatory tank closure and replacement.

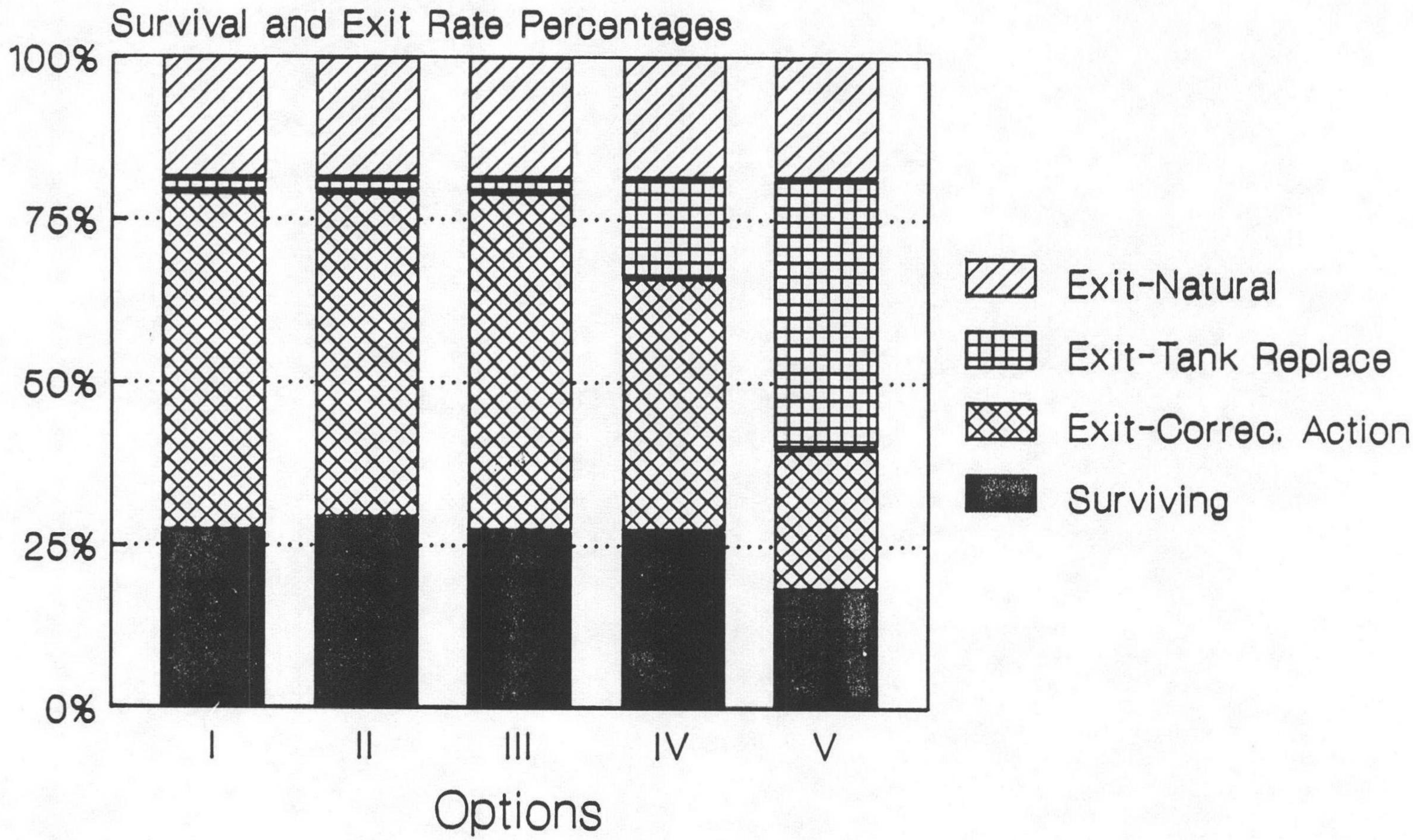
- Exits attributed to corrective action--this category of exit includes those where the firm owning the outlet could meet all UST regulatory costs other than those of corrective action but would fail if forced to incur corrective action costs.

When a firm fails as a result of a large release it cannot afford to clean up, the exit of its affected outlets could be attributed either to the costs of tank replacement or the costs of corrective action, because either cost by itself may be sufficient to cause the firm to fail. In this analysis, such exits are attributed to the costs of tank replacement.

Exhibits 6.15 and 6.16 show the percentage of small-firm-owned outlets surviving and exiting by the end of year 5 for each regulatory option. These

IMPACT OF REGULATORY OPTIONS

Percentage of Outlets Owned by Small Firms Surviving and Exiting by Year 5 *



* This analysis assumes no revenue increases.

Ex 6.16
IMPACT OF REGULATORY OPTIC ASSUMING NO REVENUE INCREASE: CUMULATIVE PERCENTAGE OF OUTLETS OWNED BY SMALL FIRMS 1/ SURVIVING AND EXITING THROUGH YEAR 5

	Option				
	I	II	III	IV	V
Natural Exit Through Year 5 2/	19	19	19	19	19
Exit - Tank Replacement or Upgrade Through Year 5 3/	2	2	2	15	41
Exit - Corrective Action Through Year 5 4/	52	50	52	39	22
TOTAL EXIT Through Year 5	73	71	73	73	18
Surviving Through Year 5	27	29	27	27	18

Source: Meridian Research, Inc. and Versar Inc., using affordability model results.

1/ Small firms are defined as firms with annual sales of less than $4.6 million.

2/ Natural exit is based on an extrapolation of past exit trends for outlets owned by small firms and the replacement of failed tanks that these firms would have replaced even in the absence of further UST regulation.

3/ Exit caused by leak detection, replacement of leaking tanks, and mandatory tank retirement or upgrading costs.

4/ Exit caused by corrective action costs.

exhibits show that natural exit would account for the exit of 19 percent of such outlets by the end of year 5.

At the close of year 5, all of the Options are very similar in their effects on the percentage of outlets surviving: between 18 and 29 percent of small-firm-owned outlets are predicted to be in business. Option II has the highest percentage of outlets surviving (29 percent), and Option V has the lowest (18 percent). The reason that Option V has the lowest percentage of surviving outlets is that, under this option, firms must incur the high costs of replacing their tanks with new tanks having secondary containment.

In Options I, II, and III, the impacts of corrective action costs cause almost all of the exits for outlets owned by small firms (between 50 and 52 percent); the impacts of replacing or upgrading tanks are very minor by comparison, causing only 2 percent of all exits under these three options. Exits attributed to corrective action are high because almost all small firms that experience a high-cost release are forced into bankruptcy, and all impacts of corrective action are attributed to corrective action requirements.

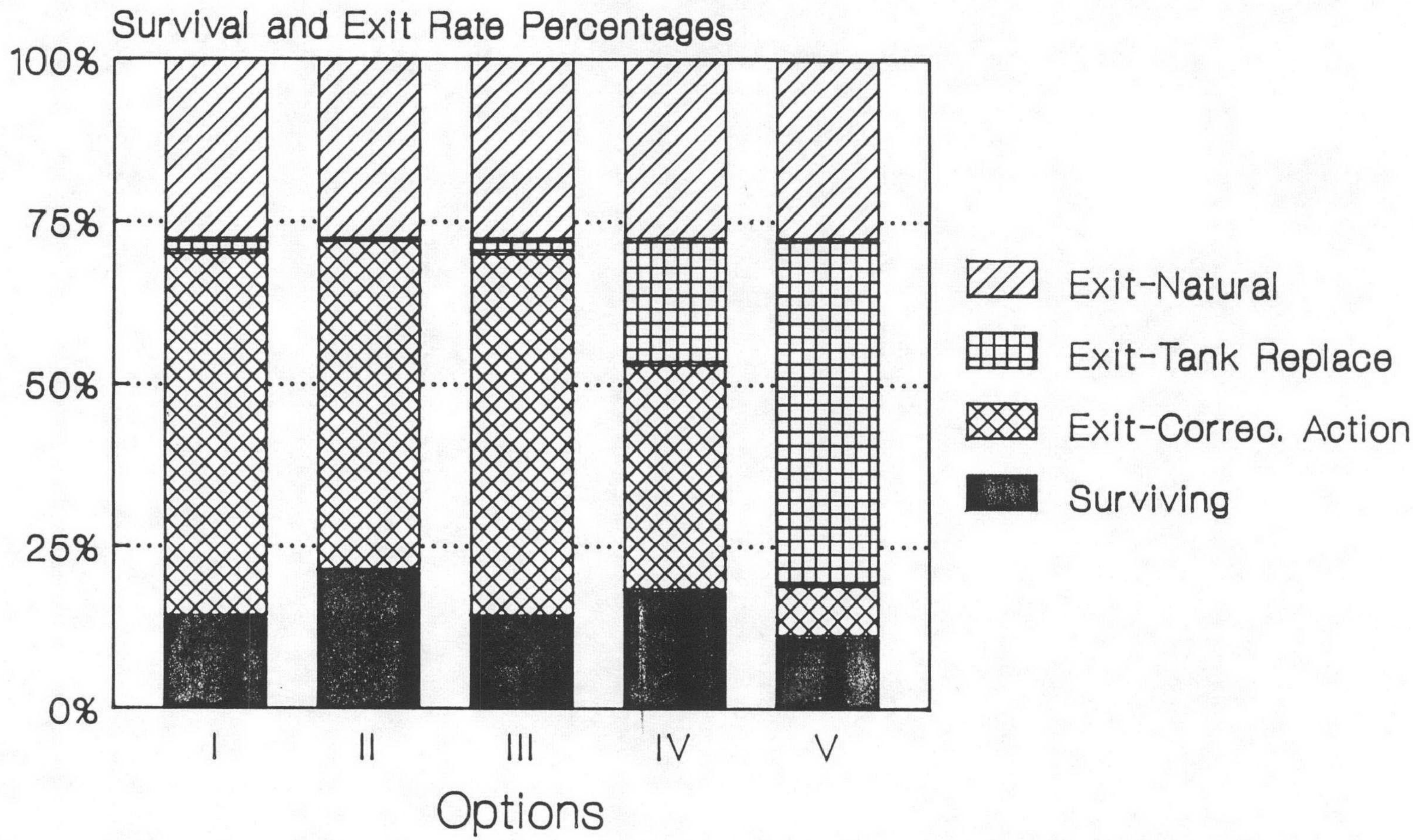
Under Option IV, the impact of tank replacement or upgrading causes 15 percent of all exits above natural exits. This is equal to 38 percent of the exits caused by corrective action (39 percent of all exits above natural exits). Under Option V, 41 percent of all exits above natural exit are caused by tank replacement or upgrading and 22 percent of exits are caused by the impact of corrective action expenditures. Option V, which requires mandatory tank retirement and the most stringent leak detection measures, thus prevents many more exits due to corrective action than the other options but still results in a large percentage of exits because of the high costs of replacing tanks.

Exhibits 6.17 and 6.18 show the percentage of small-firm-owned outlets that are predicted to survive or exit at the end of year 10 for each regulatory option; Exhibits 6.19 and 6.20 show the same data for the end of year 15. As would be expected, the percentage of outlets surviving is lower in subsequent years. Under all options, natural exits account for an increasing percentage of total exits for outlets owned by small firms at the close of years 10 and 15. During these later years, Options I, II, and III remain similar in their impacts, i.e., the impacts of corrective action costs continue to be the primary source of exit above natural exit. It is interesting that by years 6-10 under Option II (see Exhibit 6.18) tank replacement or upgrading does not cause any more exits than in the baseline and that by years 11-15 (see Exhibit 6.20), exit caused by tank replacement or upgrading under Option II would actually be lower than natural exit.

Under Option IV, the proportion of exits caused by tank replacement or upgrade compared to corrective action shifts in later years. In years 6-10, tank replacement or upgrade causes 35 percent of all exits above natural exit and by years 11-15, 42 percent. Under Option V, the importance of tank replacement or upgrade as a source of exit increases in later years to the point where it accounts for 95 percent of exit above natural exit in years 11-15.

IMPACT OF REGULATORY OPTIONS

Percentage of Outlets Owned by Small Firms Surviving and Exiting by Year 10 *



This analysis assumes no revenue increases.

Ey t 6.18

IMPACT OF REGULATORY OPTI ASSUMING NO REVENUE INCREASE:
CUMULATIVE PERCENTAGE OF OUTLETS OWNED BY SMALL FIRMS 1/
SURVIVING AND EXITING THROUGH YEAR 10

	Option				
	I	II	III	IV	V
Natural Exit Through Year 10 2/	28	28	28	28	28
Exit - Tank Replacement or Upgrade Through Year 10 3/	2	0	2	19	53
Exit - Corrective Action Through Year 10 4/	56	51	56	35	8
TOTAL EXIT Through Year 1	86	79	86	82	89
Surviving Through Year 10	14	21	14	18	11

Source: Meridian Research, Inc. and Versar Inc., using affordability model results.

1/ Small firms are defined as firms with annual sales of less than $4.6 million.

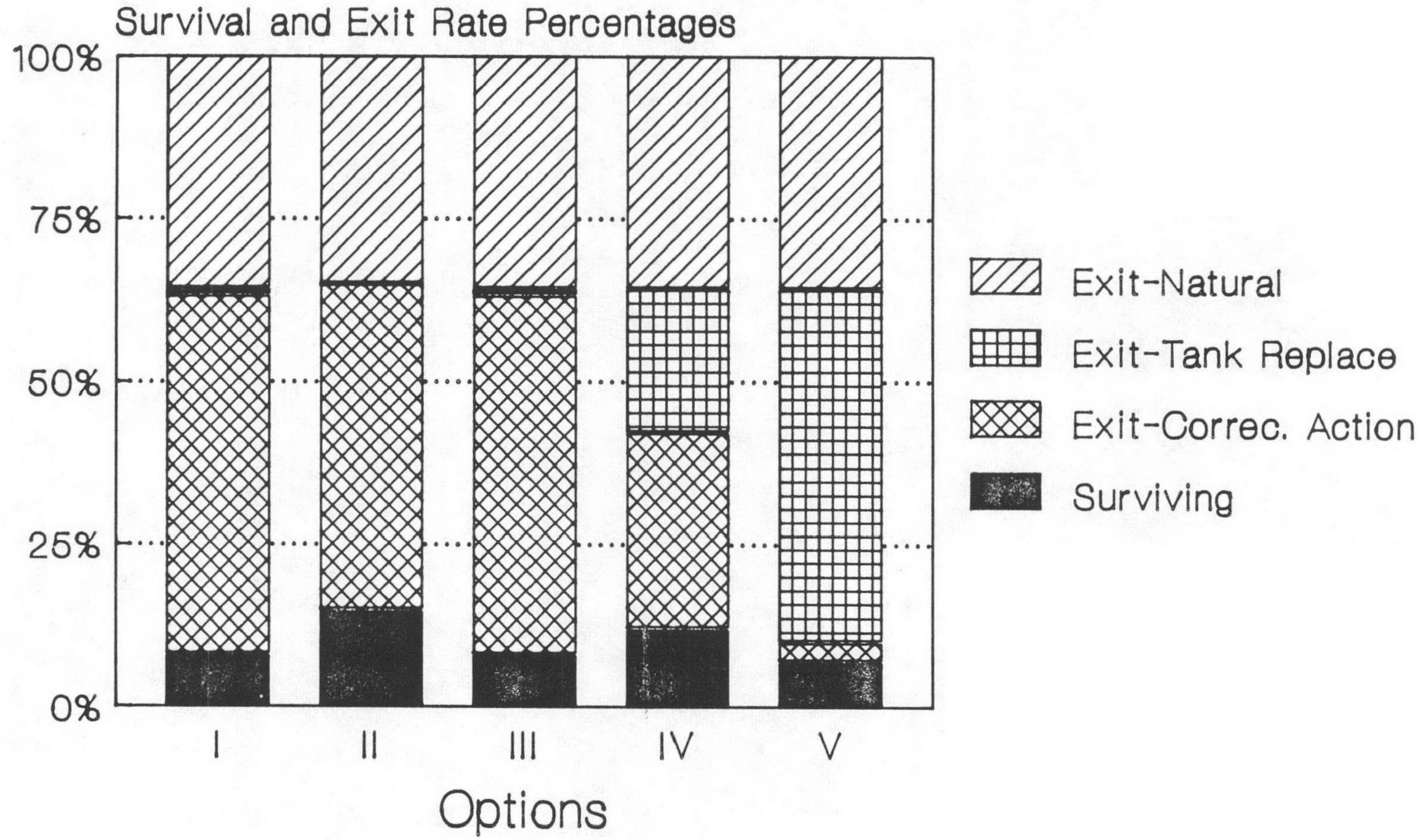
2/ Natural exit is based on an extrapolation of past exit trends for outlets owned by small firms and the replacement of failed tanks that these firms would have replaced even in the absence of further UST regulation.

3/ Exit caused by leak detection, replacement of leaking tanks, and mandatory tank retirement or upgrading costs.

4/ Exit caused by corrective action costs.

IMPACT OF REGULATORY OPTIONS

Percentage of Outlets Owned by Small Firms Surviving and Exiting by Year 15 *



* This analysis assumes no revenue increases.

Exh 6.20
IMPACT OF REGULATORY OPTIONS, ASSUMING NO REVENUE INCREASE:
CUMULATIVE PERCENTAGE OF OUTLETS OWNED BY SMALL FIRMS 1/
SURVIVING AND EXITING THROUGH YEAR 15

	Option				
	I	II	III	IV	V
Natural Exit Through Year 15 2/	36	36	36	36	36
Exit - Tank Replacement or Upgrade Through Year 15 3/	1	-2	1	22	54
Exit - Corrective Action Through Year 15 4/	55	51	55	30	3
TOTAL EXIT Through Year 15	92	85	92	88	93
Surviving Through Year 15	8	15	8	12	7

Source: Meridian Research, Inc. and Versar Inc., using affordability model results.

1/ Small firms are defined as firms with annual sales of less than $4.6 million.

2/ Natural exit is based on an extrapolation of past exit trends for outlets owned by small firms and the replacement of failed tanks that these firms would have replaced even in the absence of further UST regulation.

3/ Exit caused by leak detection, replacement, of leaking tanks, and mandatory tank retirement or upgrading costs.

4/ Exit caused by corrective action costs.

These results show that in terms of the percentage of surviving outlets owned by small firms, Option II is at least as good as the other options considered. In terms of the economic impacts of tank replacement or upgrade alone, Option II is superior to the other options considered.

Analysis of the Impact of Regulatory Options on the Profitability of Large Firms, Assuming No Revenue Increase

The impacts of the regulatory expenditures potentially imposed by Options I through V on the ratios of net income to total assets of large firms (excluding large oil companies) were analyzed, assuming no revenue increases. This analysis compared the initial (i.e., 1983-84) ratio of net income to total assets with the value of this ratio after these firms had incurred one year of regulatory costs. Because the analysis did not consider the impact of any decline in assets that might have been caused by the need of these firms to finance previous UST regulatory expenditures or the costs of servicing any debt incurred to finance such previous expenditures, the ratios of net income to total assets reported here are accurate only for the first year in which regulatory costs are assumed to be incurred; in subsequent years, the cumulative impact of regulatory costs on these ratios is seriously underestimated in this analysis. As a consequence, the large-firm net income to total asset ratios reported for years 6-10 and years 11-15 are useful primarily for making gross comparisons of the levels and types of costs that would be required in these two subsequent 5-year intervals with those imposed in the first 5-year period.

The impacts on large firms of the regulatory costs associated with the options under consideration are reported in two stages. First, the impacts of tank replacement costs (i.e., leak detection, upgrading of tanks, mandatory tank retirement) are reported. Next, the impacts of all regulatory costs, including corrective action clean-up costs, are reported.

Exhibit 6.21 shows the initial average value of the ratio of net income to total assets per outlet for large firms and the average value of this ratio after regulatory costs have been incurred during years 1-5, 6-10, and 11-15 under the five regulatory options. The initial average ratio of net income to total assets per large-firm-owned outlet in 1983-84 is .042 (or a 4.2 percent return on assets), well below the 7 percent long-term average for this ratio for most businesses. Though 1986 return on assets data are not yet available for large firms in this sector, profits for these large firms (other than refining companies) are expected to be higher in 1986 than in recent years, although they may return to their former levels if oil prices stabilize or increase.

As Exhibit 6.21 shows, the impact of the total of average annual regulatory costs incurred during years 1 through 5 causes the net income per outlet for large firms to become negative. This implies that, in the absence of revenue increases, large firms can expect 5 years of losses under any of the options considered. By years 6-10, regulatory costs would cause a smaller impact on profits; average net income per outlet continues to be negative under all options except Option II, where it is zero. By years 11-15, the regulatory costs associated with options II, IV, and V would allow average

Exhibit 6.21
IMPACTS OF REGULATORY EXPENDITURES ON THE RATIOS OF NET INCOME TO TOTAL ASSETS PER OUTLET FOR LARGE FIRMS 1/ (EXCLUDING LARGE OIL COMPANIES), ASSUMING NO REVENUE INCREASE

	Option				
	I	II	III	IV	V
Initial Average Per Outlet Ratio of Net Income to Total Assets (for 1983-1984)	.042	.042	.042	.042	.042
Revised Ratio of Net Income to Total Assets Caused by Tank Upgrade or Replacement Costs[b] Incurred Annually During Years 1-5	.040	.038	.040	.035	.009
Revised Ratio of Net Income to Total Assets Caused by All Regulatory Costs[c] Incurred Annually During Years 1-5	-.099	-.086	-.100	-.101	-.027
ised Ratio of Net Income to Total Assets Caused by Tank Upgrade or Replacement Costs Incurred Annually During Years 6-10 2/	.048	.048	.048	.042	.021
Revised Ratio of Net Income to Total Assets Caused by All Regulatory Costs Incurred Annually During Years 6-10[c]	-.026	.000	-.025	-.010	-.027
Revised Ratio of Net Income to Total Assets Caused by Tank Upgrade or Replacement Costs Incurred Annually During Years 11-15 2/	.047	.051	.049	.054	.051
Revised Ratio of Net Income to Total Assets Caused by All Regulatory Costs Incurred Annually During Years 11-15 3/	-.023	.020	-.020	.005	.038

Source: Meridian Research, Inc. and Versar Inc., using affordability model results.

1/ Large firms are defined as firms with annual sales greater than $4.6 million that do not engage in petroleum production or refining.

2/ Tank replacement or upgrade costs include costs of leak detection/monitoring, mandatory tank upgrading, replacement of tanks that cannot be repaired after a release, and mandatory tank closure and replacement.

3/ Total annual regulatory costs include tank replacement and corrective action costs.

profits per large-firm-owned outlet to be positive. Profits per large-firm-owned outlet would continue to be negative under Options I and III.

The relative impacts of the options vary by time period. For years 1-5, option II has the least impact on profitability; options I, II and IV are very similar; and option V has the most severe impacts on profitability. By years 11-15, those options involving mandatory tank retirement or upgrading (options II, IV and V) allow greater profitability for large firms than options I and II, which permit older tanks to remain in place (as long as they do not have to be replaced because of releases).

The effect of paying tank upgrade or replacement costs alone causes profits in years 1-5 to rise under all options by years 11-15. Under Options I, II, III, and IV, pre-regulation profit levels are reached by years 6-10 if only the costs of tank upgrading and replacement are considered. Under Option V, if only the costs of tank upgrading and replacement are considered, large firms have higher rates of return by years 11-15 than their pre-regulation rates of return.

<u>Analysis of the Impacts of Regulatory Options on Outlets Owned by Small Firms, Assuming That Revenue Increases Are Possible</u>

The analysis was performed assuming that the revenues of motor fuel marketing firms will not increase to cover their increased regulatory costs. However, the revenues of these firms could increase, for two different reasons:

- The price of retail motor fuels could rise and provide a higher margin that could be used to pay regulatory costs.
- As outlets exit the industry, the volume of motor fuel sales at the remaining outlets could increase. This increase in volume would provide the firm with higher profits, because, on the margin, the relative fixed costs of operation would decline. This would enable owners to pay their regulatory costs from this higher profit margin.

In the retail motor fuel marketing sector, a 1 percent revenue increase with no cost increase can be achieved either by a 1 percent price increase (with no change in the volume of motor fuels sold) or a 12-15 percent increase in the volume of motor fuels sold (with no change in price).

Exhibit 6.22 compares the percentage of outlets owned by small firms surviving at the close of years 5, 10, and 15 under the following scenarios: if no additional UST regulations are imposed; if Option II regulations are imposed and there is no revenue increase; and if Option II regulations are imposed and revenue increases of 1, 3, or 5 percent occur, respectively. The "<u>base case</u>," i.e., the percentage of outlets surviving if no additional UST <u>regulations</u> are imposed, is the benchmark for measuring the incremental impacts associated with the other scenarios. As Exhibit 6.22 shows, if existing outlets continue to exit the industry at this base rate, 81 percent of small-firm-owned outlets existing today will continue to survive at the end of 5 years. Even a 5 percent revenue increase is not quite sufficient to maintain the base case survival rate at the end of year 5 if the owners incur all Option II regulatory costs (including corrective action costs). However, by

Exhibit 6.22
ECONOMIC IMPACTS OF REGULATION UNDER OPTION II ON SMALL FIRMS IN THE RETAIL MOTOR FUEL MARKETING INDUSTRY, ASSUMING REVENUE INCREASES OF 1, 3, OR 5 PERCENT

	Percentage of Outlets Surviving		
Scenario	Year 5	Year 10	Year 15
Base Case - No Further UST Regulation			
Survival Based on the Continuation of Past Exit Trends	81	72	64
Regulation Under Option II			
No Revenue Increase			
Tank Upgrade Only	79	72	65
All Regulatory Costs	29	21	15
1 percent Revenue Increase			
Tank Upgrade Only	97	96	94
All Regulatory Costs	41	32	25
3 percent Revenue Increase			
Tank Upgrade Only	100	99	99
All Regulatory Costs	62	54	47
5 percent Revenue Increase			
Tank Upgrade Only	100	100	99
All Regulatory Costs	74	68	63

Source: Meridian Research, Inc. and Versar Inc., using affordability model results.

year 10, a 5 percent revenue increase will almost maintain base case survival rates. Thus it is possible that a relatively modest price increase, or a relatively large increase in the volume of retail motor fuel sold (or some combination of these two) could help to mitigate the adverse impacts of Option II UST regulations on the survival of small-firm-owned outlets in this segment.

Exhibit 6.23 compares the average per outlet ratio of net income to total assets for large firms for the base case and the same revenue increase scenarios as were shown in Exhibit 6.22 for small firms. For large firms, a 3 percent revenue increase would be adequate to achieve a higher ratio of net income to total assets per outlet than exists in the base case. By years 6-10, a 1 percent revenue increase would be adequate to achieve slightly greater than base case rates of return on assets.

If all of the firms in an industry incur the same cost increase, economic theory suggests that, in the long run, prices will rise to cover these costs (although the industry's total output may decline). However, if all of the firms in the industry do not incur the same cost increase, the ability of those firms incurring higher costs to increase prices to cover these costs is constrained.

In the UST regulatory context, all firms will not incur the same cost increases. The cost increases that are the source of most of the impacts for Option II are those for corrective action. These costs will rarely be incurred by new outlets or those with upgraded tanks. Even among firms owning older bare steel tanks, the costs of corrective action will vary randomly in any given year. Some small firms will, through good luck alone, have no releases. Others may only have releases costing less than $50,000, and some small firms will have releases costing more than $100,000. Large firms, with greater numbers of outlets, will have less variation in their annual costs. For example, a firm with 100 outlets can expect in any given year to incur costs for all outlets approximately equal to the average cost per outlet times the number of outlets (approximately $27,000 per outlet for years 1-5 of Option II). A large firm will have better access to credit to cover an unusually costly year than a small firm will. As a result of these factors, large firms will typically have higher costs per outlet than small firms that are fortunate enough to have no releases, but much lower costs than small firms with a large plume release. In the absence of insurance or other risk pooling measures (risk retention associations or State funds), a price increase adequate to ensure profitability for large firms would still not be adequate to forestall closure for those small firms incurring the costs of an expensive corrective action.

The results in Exhibit 6.23 show that a 3 percent revenue increase is adequate to ensure large firms a considerably better rate of return in any post-regulatory interval than they have today. However, with this same revenue increase, 19 percent of the outlets owned by small firms will be forced to exit as a result of regulatory costs by year 5.

However, an increase of 3 percent may not be possible even for older outlets owned by large firms. Attempts by firms with older outlets to maintain prices at a level significantly above the price at which gasoline can be sold at newly constructed outlets will not succeed over the long run, particularly

Exhibit 6.23

ECONOMIC IMPACT OF REGULATION UNDER OPTION II ON THE RATIO OF NET INCOME TO TOTAL ASSETS PER OUTLET FOR LARGE FIRMS, 1/ ASSUMING REVENUE INCREASES OF 1, 3, OR 5 PERCENT

Scenario	Value of the Ratio of Net Income to Total Assets per Outlet During: Years 1 - 5	Years 6 - 10	Years 11 - 15
Base Case - No Further UST Regulation			
No Revenue Increase	.042	.042	.042
Regulation Under Option II			
No Revenue Increase			
Tank Upgrade Only	.038	.048	.051
All Regulatory Costs	-.086	.000	.020
1 Percent Revenue Increase			
Tank Upgrade Only	.077	.085	.088
All Regulatory Costs	-.019	.046	.061
3 Percent Revenue Increase			
Tank Upgrade Only	.147	.155	.157
All Regulatory Costs	.071	.119	.132
5 Percent Revenue Increase			
Tank Upgrade Only	.216	.224	.226
All Regulatory Costs	.142	.188	.201

Source: Meridian Research, Inc. and Versar, Inc., using affordability model results.

1/ Large firms are defined as firms with annual sales greater than $4.6 million that do not engage in petroleum production or refining.

in an industry such as retail gasoline marketing, where the cost of entry is relatively low. For example, a new convenience store with both gasoline and grocery sales can be constructed and stocked for less than $250,000; this figure is only three times the cost of replacing the tanks at an existing station and is less than the cost of a large corrective action.

The primary limitation on the ability of existing outlets to increase their sales when other outlets exit the industry is that new entrants with protected tanks may be able to price their motor fuels at a level lower than that of existing outlets, which may have to recoup corrective action or tank retrofit costs they have incurred.

Impact on Outlets Operated by Lessee Dealers

Outlets operated by lessee dealers represent a peculiar combination of large and small firms. As shown in Exhibit 6.3, 36,817 leased outlets (62.8 percent) are owned by refiners, 20,713 leased outlets (35.3 percent) are owned by jobbers, and 1,127 leased outlets (1.9 percent) are owned by independent chains. All of the refiners and independent chains, and virtually all of the jobbers, are large businesses. All lessee dealers themselves, however, are small businesses.

The median financial statistics for single-station lessee dealers (who comprise about three-quarters of all lessee dealers) are: $82,000 in assets, $62,000 in net worth, $6,000 in annual after-tax profits, and a rate of return on assets of 7.2 percent. This compares with $210,000 in assets, $90,000 in net worth, $14,000 in annual after-tax profits, and a rate of return on assets of 6.67 percent for the median open dealer; thus the average lessee dealer has less than half the assets of the average open dealer but has a similar rate of return.

The impact on lessee dealers depends critically on who bears the initial impact and whether it can be passed on. Under the most common current lease arrangements, the owner of the outlet also owns the tank, and thus the owner bears the principal impact. In the long run, however, there is considerable question about whether the owner will actually bear the burden. One possibility, which some lessors are already attempting, is to change the terms of the lease to make the lessee bear greater direct responsibility for the tanks themselves. Another possibility, at least for leases that expire within five or ten years, is to raise the rent to cover at least the routine regulatory costs (if not the costs associated with an actual release and tank replacement).

To the extent that the owner bears the impacts of costs, this lessee dealer analysis is similar to that for outlets owned by large firms. As shown in Exhibit 6.21, the impact on large firms of tank replacement costs only is relatively small, and it is unlikely that these costs would cause an owner to close a lessee dealership or substantially change the terms of the lease. Corrective action costs under all options, however, have substantial impacts on the profitability of large firms, which may cause them to close lessee-operated outlets. If large firms can increase revenues by 3 percent, there would be little if any impact on their lessee dealers under Option II.

If rates of return are reduced to less than 3 percent, there is a strong incentive to pass costs through to the lessee. Thus it is instructive to look at the potential impacts on lessees if they are required to bear these costs. This analysis is similar to that for open dealers (presented above). An analysis of the median lessee dealer shows that:

- The median lessee would be forced into severe financial distress as a result of having to clean up a non-plume release and would fail as a result of having to replace one tank.

- The median lessee--like the median open dealer--would fail in the event of a plume release even before the leaking tank is closed and replaced.

- The median lessee would be pushed at least to the brink of failure if required to replace one tank.

For the median lessee-operated outlet, the costs of a non-plume release are equal to two-thirds of net worth; the costs of a plume release are over twice such a dealer's net worth, and the costs of closing and replacing one tank exceed half of the lessee's net worth. In contrast to these impacts, the impacts on the typical lessee dealer of upgrading a tank are relatively modest. The $3,050 cost of cathodically protecting a tank would leave the median lessee in good financial condition, with a return on assets of 4.1 percent in the year in which this cost is incurred.

The impact of the regulatory options on lessees is difficult to judge, for several reasons. The owner of the outlet is clearly somewhat better able to sustain the impact of regulatory costs than the lessee, since in the long run the lessor firm's profits remain positive and large owners are better able to sustain the short-run losses related to a release than is a lessee of a single outlet. The exact terms of a lease, however, will play a critical role in who bears the ultimate burden. The strategic goals of the owner may also play a role. If the outlet is marginal, for example, the owner may not want to assume the risk and may aggressively try to shift the risk and burden to the lessee, which would tend to increase the chances of the lessee's failure. There is also a possibility that an owner would close a site to minimize outlays for corrective action (e.g., replacing a tank) or would take the opportunity to change the use of the site (e.g., from full service to "pumper") if the site location were especially valuable. In this type of situation a lessee could be forced out of business even if he did not directly bear the costs of regulation or of corrective action. Lease arrangements that clearly hold the owner responsible for major costs of corrective action and tank replacement provide a lessee with considerable protection. Yet if these costs can be passed through, their impact on lessees will generally be greater than the impacts on open dealers.

6.B.4 Interactions with Financial Responsibility Requirements

This economic impact analysis assumes that there will be no insurance or State corrective action and compensation funds available to pay the costs of corrective action or other expenditures required by the UST technical standards. EPA is also issuing proposed financial responsibility requirements for owners and operators of USTs. These requirements are covered in a separate regulatory impact analysis (RIA).

The proposed financial responsibility requirements will require that all UST owners or operators provide financial responsibility in the amount of $1,000,000 per occurrence and an annual aggregate amount in accordance with the following schedule:

Aggregate Level	Number of Tanks Covered
$1 million	1-12
$2 million	13-60
$3 million	61-140
$4 million	141-250
$5 million	251-340
$6 million	341 or more

The proposed regulation allows an owner or operator to satisfy these financial responsibility requirements by means of any one, or a combination, of the following financial mechanisms: insurance, guarantee, indemnity agreement, surety bond, letter of credit, qualification as a self-insurer, or State or local corrective action and compensation fund. Subtitle I allows the Administrator to suspend the Agency's enforcement of these financial responsibility requirements if a class of UST facilities is unable to obtain mechanisms for financial responsibility and additionally meets certain conditions with regard to taking steps to form a risk retention group or if the State takes certain steps toward forming a State fund.

Of the mechanisms that can be used to satisfy an owner or operator's financial responsibility requirements, only insurance and State corrective action and compensation funds have the potential to mitigate significantly the economic impacts of the technical standards. Insurance is currently available only to multi-facility chains other than refiners. In the small business segment of the retail motor fuel marketing sector, insurance is available only to small jobbers and small C-store chains and is not available to open dealers. There is no active market for UST insurance in the many UST-using industry sectors other than retail motor fuel marketing.

Both the future availability and future costs of insurance to cover corrective action and compensation of third parties resulting from UST releases are uncertain. In the Financial Responsibility RIA, EPA estimated the costs of insurance based on current UST insurance premiums and on projections of insurance premium costs for 1987 provided by the leading current insurer of USTs. The Financial Responsibility RIA examines the availability of UST insurance using various alternative scenarios that estimate how many USTs that are not currently insured will be able to obtain insurance in the future.

The availability of insurance is currently limited both by capacity constraints within the insurance industry and by the number of USTs that fit the profile that insurers are willing to insure. Currently, insurers limit UST insurance to firms:

- Having USTs with an average age of no greater than 17 years, or, in the case of some insurers, with an age of less than 20 years;
- Belonging to an industry association; and
- Having records documenting a minimum of 6 months of daily inventory control before applying for insurance.

In the future, insurers may drop the requirement that a firm belong to an industry association, but a more stringent requirement than inventory control for the prior identification of releases, such as tank tightness testing, may become a precondition to obtaining UST insurance. Prior identification of releases is important to insurers because policies do not cover claims for damages from UST releases identified before the effective date of the policy.

As a result of these restrictions and the nature of the insurance claims process, the number of UST releases covered by insurance will be significantly less than the total number of UST releases. Specific reasons for these differences are the following:

- To the extent possible, insurance excludes coverage for prior releases because it requires owners to furnish inventory control records or to perform other release identification measures before a policy is issued; however, prior releases are expected to constitute a substantial portion of all UST releases identified within the next 5 years.
- The tank age restrictions imposed by insurers exclude that segment of the total UST population most likely to have the highest probability of releases.
- Firms covered by insurance do not report all releases to insurers. In particular, releases having costs that are less than the policy's deductible may not be reported to insurers.

As a result of the factors listed above, the insurance claims rates and premium costs used in the Financial Responsibility RIA are considerably lower than implied by the probabilities of corrective action estimated in this RIA. A further factor differentiating the two analyses is that insurance claims rates are based on existing tank replacement practices while the technical standards RIA assumes that tanks are not replaced unless they have a release; which is an assumption necessary to the development of the maximum impact scenario for that RIA. As a result of these differences, the insurance claims rates cannot be compared to the probabilities and costs of corrective action events developed elsewhere in this RIA.

Insurance will thus be available only to a portion of small UST-using businesses, and then only to cover some of the potential costs of corrective action. Initially, insurance will be available only to a limited number of small businesses, and these will be those businesses least likely to experience a release requiring corrective action. Over the long run, a larger portion of the affected small businesses may become eligible for insurance as existing releases are corrected and as old tanks are replaced or upgraded.

For those small businesses able to obtain insurance, the Financial Responsibility RIA found the mitigative effect of insurance on the economic impacts of the technical standards to be minimal. Leak detection and tank upgrading/replacement costs are not covered by UST insurance, and thus insurance has no effect on the impacts of these costs. Insurance will pay for corrective action costs above the level of the deductible in the policy (normally $5,000 for small businesses).

For those small businesses able to obtain insurance, the Financial Responsibility RIA found that initially an estimated 0.7 percent of small business-owned outlets would close as a result of the costs of insurance premiums. However, over the long run (10 years), EPA estimates that fewer firms would exit the industry if they had UST insurance than if they did not. The costs of insurance premiums thus force some low-profit, marginal open dealer firms to close. However, among larger, more profitable open dealer firms and small business chains, fewer outlets would close because of paying insurance premiums than would close as a result of meeting the costs of their UST-related corrective action and third-party liability awards from their own funds.

Currently, there are no State compensation and liability funds that fully meet Subtitle I's requirements for use as a financial responsibility mechanism. The extent to which such programs mitigate economic impacts depends on how they are set up. At one extreme, a fund that paid for all corrective actions and provided low-interest loans to small businesses for tank replacement and that was based on a gasoline tax would virtually eliminate the economic impacts on small business of the technical standards. At the other extreme a fund based on tank fees and that paid only corrective action costs for financially insolvent UST owners or operators would do nothing to mitigate the economic impacts of these standards on small businesses.

In summary, unless the availability of insurance and types of firms able to obtain it alter greatly, insurance will not significantly mitigate small business economic impacts. State compensation and liability funds may mitigate the economic impacts of the technical standards, but it is uncertain whether such funds will come into being and whether they will be designed in a way that permits them to mitigate economic impacts.

6.C. IMPACTS ON FIRMS USING USTS FOR NONRETAIL MOTOR FUEL STORAGE

The UST regulations will impose requirements on facilities in many other industries besides those that sell motor fuels at retail, including those storing petroleum products for their own use or for the wholesale market. This section analyzes potential economic impacts in industries (other than retail gasoline sellers) that have been identified as including significant numbers of petroleum tank owners.

This section identifies those industries that are likely to be affected by UST regulations because a significant fraction of the facilities in the industry own or operate underground tanks which contain petroleum products. The industries selected are based on a detailed analysis of underground tanks in California. These nonretail petroleum product tanks are primarily used to service in-house vehicles (noncommercial tanks of less than 1100 gallons are exempt). Depending on the nature of competition in the specific industry and the relative position of the firm, a variety of responses to the imposition of regulatory costs are possible.

- o In many industries, the costs of tank ownership are small relative to the overall cost and activity structure of the average facility. Expected levels of regulatory costs could be absorbed without significant impacts on profitability.

- o In industries in which a large number of firms must meet the regulatory requirements (i.e., where a large percent of the firms in the industry have underground tanks), the fact that a firm's competitors face similar increases in costs may permit cost pass-throughs.

- o In industries in which there is little competition among the firms--for example, because of geographic market segmentation or a high degree of product differentiation--a firm facing increased regulatory costs may also pass all or part of these costs on to consumers, as it is not likely to lose the customers to competitors. Tank-owning firms that are defense contractors to the federal government typically meet this description.

- o The study identifies many industries in which only a small percent of firms have tanks, the tank-owning firms have only one or two petroleum tanks, and the firm is likely to have close competitors that do not operate underground tanks. If the regulatory costs are relatively high, they can be expected to take tanks out of service and purchase the needed gasoline or other petroleum products from retailers. In this case the firm could save the costs of owning and operating the tank, capture some salvage value from the used tanks, and avoid the costs of regulatory compliance. These would be partially offset by the increase in retail costs over wholesale costs for supplying its petroleum needs.

- o Part of the cost of any regulatory requirement will be shifted to the public, including both consumers and nonconsumers, through the lowering of corporate taxable income. This arises from deductions for higher operating costs, tax credits for investment, and--if price rises result in decreased sales--lower net income from sales. The public is also likely to pay when the tank owner is a government entity rather than a private corporation.

6.C.1. Overview of Approach

The first step in the analysis is identifying the affected industries. The analysis was performed for those industries that own nonretail petroleum underground storage tanks. Available data were used to estimate the fraction of each industry that owns USTs and the average number of tanks per facility for that fraction of the industry. The potential burden for tank-owning firms in each industry was determined by a screening analysis. This analysis essentially compares potential regulatory costs to profits for firms of different size classes within the affected 4-digit SIC code industry groups.

Identify the Industries with Relatively Large Numbers of USTs

A complete registry of underground storage tanks exists for the State of California. (Similar data are not yet available from other states or on a national basis.) This database has been processed to identify the industry category of each UST-owning firm, the number of tanks, their size, and their contents. This serves as the data base for the assumed distribution of nonretail petroleum tanks across SICs and within SICs. Based on available data, nonretail petroleum tanks are used in all major sectors of the economy: mining and construction, manufacturing, wholesale trade, retail trade, and services. (USTs are also prevalent in agriculture, utilities, and transportation sectors, but are not included [in this draft] because of difficulties in developing financial profiles.) There are also tanks owned by public-sector entities and nonprofit organizations. However, data on their incidence are not available, so they have not been included in this analysis.

Estimate the Fraction of Each Industry Group that Owns Tanks and Estimate the Average Number of Tanks per Tank-Owning Facility

An EPA contractor report identifies the number of UST-owning facilities in California for each SIC code in the database, and identifies the number of tanks in each SIC category. Using the "County Business Patterns" publication of the 1982 Census, we identified the total number of establishments in the state for each relevant SIC code, and thus we were able to calculate the percentage of establishments in each SIC code that uses USTs for nonretail petroleum products. This percentage is used as an estimate of the nationwide percentage of firms owning tanks for each industry. For petroleum tanks other than retail gasoline sellers, the value ranges from 100 percent (paper mills) to less than one percent (liquor stores, engineering and architectural services). (Since the number of facilities with tanks and the number of facilities in the state come from different sources several years apart, the percent of each industry owning tanks is only a rough approximation.) In the screening results presented below, only those SICs for which greater than five percent of establishments have nonretail petroleum tanks are presented. It is assumed that, if only a small percentage of establishments within the industry maintain underground tanks, there are alternatives which would tend to limit the potential for economic dislocation.

By dividing the number of tanks by the number of UST-owning facilities, we were able to calculate the average number of tanks per tank-owning facility. For nonretail petroleum tanks this ranges from 5.6 tanks per firm (electronic computing equipment) to 1.1 (furniture stores). However, within each industry group, the number of tanks per firm ranges from zero to several times the industry's average. Presumably, bigger firms would have a larger number of tanks per firm (if only because there would be a larger number of establishments per firm). However, no data are available from which to estimate a relationship betwen firm size and number of tanks per firm in the various industries.

Compare Regulatory Compliance Costs to Significant Descriptors of Financial Performance of the Industry

We examined a number of sources of data on financial statistics of firms by industry. The one selected for use, on the basis of timeliness and completeness, is "'85 Annual Statement Studies" published by Robert Morris Associates, Philadelphia, Pa. Robert Morris Associates (RMA) is a national association of bank loan and credit officers, so the sample that forms the basis of these financial statements are presumably firms that have applied for credit in recent months.

RMA statement studies include data for many four-digit SIC code in several size categories: assets of less that one million dollars, one to ten million dollars, 10 to 50 million dollars, and 50 to 100 million dollars. (Data are provided for an asset size group only if the sample in that size range consists of at least 10 observations.) Two larger asset size groups are included, but for most industries there are fewer than 10 observations for these size groups, so detail is not presented. Furthermore, firms with large assets are likely to have multiple facilities, which would increase the regulatory costs per firm.

Regarding regulatory costs, rather than using specific costs for regulatory alternatives for this exercise, screening was performed in a more generic way. Three screening exhibits are presented:

- o Exhibit 6.25 assumes regulatory costs of $500 per tank (detection).
- o Exhibit 6.26 assumes regulatory costs of $5,000 per tank (replacement).
- o Exhibit 6.27 assumes regulatory costs of $50,000 per tank (corrective action).

The $500-per-tank detection cost may be thought of as the annual incremental costs of performing an annual tank test and would be borne by all affected tanks. Other potential regulatory costs include the incremental costs of tank replacement (i.e., those costs above and beyond the costs of normal tank replacement) and incremental costs of corrective action (i.e., those costs above and beyond the corrective action costs that would be undertaken in the absence of regulatory change). In a crude sense, incremental tank replacement costs might

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SCREENING ANALYSIS FOR NON-RETAIL PETROLEUM TANKS

Regulatory Costs of $500/Tank

	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of industry with tanks	Pretax profit per firm by firm size			UST costs per establishment	Pretax return on assets					
				Small	Medium	Large		Small		Medium		Large	
				($1000)			($1000)	Before	After	Before	After	Before	After
1311	CRUDE PETROLEUM & NATURAL GAS	8,712	54.3	109	241	418	0.9	21.1%	20.9%	4.9%	4.9%	1.7%	1.7%
1442	CONSTRUCTION SAND AND GRAVEL	2,270	54.8	32	207	--	1.5	6.3%	6.0%	7.2%	7.2%	--	--
1611	HIGHWAY AND STREET CONSTRUCTION	9,651	7.0	29	89	462	1.4	6.9%	6.6%	4.1%	4.1%	4.8%	4.8%
1761	ROOFING AND SHEET METAL WORK	17,487	5.1	24	72	--	0.8	9.0%	8.7%	5.9%	5.8%	--	--
1794	EXCAVATION AND FOUNDATION WORK	11,050	9.0	21	167	719	1.1	6.1%	5.8%	10.7%	10.6%	9.0%	9.0%
2011	MEAT PACKING PLANTS	1,689	42.0	25	529	1,755	1.1	4.0%	3.9%	12.3%	12.3%	7.7%	7.7%
2016	POULTRY DRESSING PLANTS	364	35.7	--	664	4,365	1.5	--	--	15.1%	15.1%	15.9%	15.9%
2033	CANNED FRUITS AND VEGETABLES	676	35.0	--	8	3,011	1.2	--	--	0.2%	0.2%	12.0%	12.0%
2048	PREPARED FEEDS, NEC	1,767	39.6	(42)	360	1,950	1.2	-6.7%	-6.9%	10.7%	10.6%	8.5%	8.5%
2051	BREAD, CAKE AND RELATED PRODUCTS	2,112	21.9	33	426	1,703	1.3	8.7%	8.4%	9.6%	9.6%	8.6%	8.6%
2084	WINES, BRANDY AND SPIRITS	348	28.4	--	(16)	309	1.0	--	--	-0.4%	-0.4%	1.3%	1.3%
2086	BOTTLED AND CANNED SOFT DRINKS	1,547	93.3	25	463	2,400	1.0	5.1%	4.9%	10.4%	10.4%	9.5%	9.5%
2421	SAWMILLS & PLANING MILLS	5,531	34.3	39	299	177	1.4	7.2%	7.0%	9.0%	8.9%	0.7%	0.7%
2431	MILLWORK	2,121	6.9	52	430	3,610	1.1	10.1%	9.9%	13.4%	13.4%	19.6%	19.5%
2448	WOOD PALLETS & SKIDS	1,469	17.5	54	--	--	1.1	12.3%	12.0%	-	--	--	--
2621	PAPER MILLS, EXCEPT BUILDING PAPER	350	100.0	90	353	3,086	1.7	16.4%	16.1%	10.1%	10.0%	12.2%	12.1%
2711	NEWSPAPERS	8,223	6.3	42	277	2,599	1.3	8.3%	8.0%	7.3%	7.2%	12.1%	12.1%
2831	PHARMACEUTICAL PREPARATIONS	666	13.1	75	351	3,163	1.4	14.5%	14.2%	11.2%	11.2%	12.8%	12.8%
2851	PAINTS & ALLIED PRODUCTS	1,379	19.9	49	310	3,013	0.8	8.7%	8.6%	8.5%	8.4%	12.6%	12.6%
2861	INDUSTRIAL INORGANIC CHEMICALS, NEC	582	30.6	38	326	1,618	0.8	7.0%	6.9%	9.1%	9.1%	6.1%	6.1%
2911	PETROLEUM REFINING	460	53.1	--	1,202	3,741	1.4	--	--	32.7%	32.7%	17.1%	17.1%
3273	READY-MIXED CONCRETE	5,088	67.5	54	241	1,741	1.1	9.1%	8.9%	7.9%	7.9%	7.8%	7.8%
3312	BLAST FURNACES & STEEL MILLS	521	29.2	61	126	1,291	1.9	11.7%	11.4%	2.8%	2.8%	5.6%	5.6%
3321	GRAY IRON FOUNDRIES	867	44.4	63	148	623	1.0	14.0%	13.8%	4.0%	4.0%	2.9%	2.9%
3443	FABRICATED PLATEWORK	1,742	9.0	20	114	1,267	1.1	3.4%	3.2%	3.6%	3.6%	6.4%	6.4%
3444	SHEET METAL WORK	3,456	7.0	35	275	2,246	0.7	7.6%	7.5%	9.3%	9.3%	10.5%	10.5%
3523	FARM MACHINERY & EQUIPMENT	1,748	8.5	(9)	121	785	1.0	-1.7%	-1.8%	3.4%	3.4%	3.6%	3.6%
3662	RADIO & TV COMMUNICATION EQUIPMENT	2,059	5.5	1	288	2,632	2.0	0.2%	-0.2%	7.6%	7.5%	11.9%	11.9%
3671	SEMICONDUCTORS & RELATED DEVICES	89	9.3	73	381	3,135	0.7	13.6%	13.5%	10.7%	10.7%	13.3%	13.2%
3728	AIRCRAFT EQUIPMENT, NEC	849	9.7	43	301	--	2.2	7.2%	6.8%	8.7%	8.7%	--	--
3731	SHIP BUILDING & REPAIRING	616	23.9	(35)	189	(420)	1.5	-7.3%	-7.7%	5.0%	4.9%	-1.9%	-2.0%
4225	GENERAL WAREHOUSING AND STORAGE	2,284	26.2	45	547	--	0.8	9.4%	9.3%	14.9%	14.9%	--	--
4463	MARINE CARGO HANDLING	796	21.9	--	458	3,265	1.0	--	--	9.7%	9.7%	13.2%	13.2%
4811	TELEPHONE COMMUNICATION	13,124	42.1	104	328	3,309	1.0	20.9%	20.7%	10.0%	9.9%	13.9%	13.9%
4953	REFUSE SYSTEMS	4,251	35.8	821	228	--	1.4	188.3%	187.9%	9.5%	9.5%	--	--

Exhib .25 (Continued)

SCREENING ANALYSIS FOR NON-RETAIL PETROLEUM TANKS

Regulatory Costs of $500/Tank

	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of industry with tanks	Pretax profit per firm by firm size ($1000)			UST costs per establishment ($1000)	Pretax return on assets					
				Small	Medium	Large		Small Before	Small After	Medium Before	Medium After	Large Before	Large After
5012	AUTOMOBILES & OTHER MOTOR VEHICLES	5,829	5.2	49	268	3,342	0.9	8.4%	8.3%	8.4%	8.4%	16.3%	16.3%
5031	LUMBER, PLYWOOD & MILLWORK	6,889	9.6	58	303	1,893	0.9	10.6%	10.4%	9.4%	9.4%	9.8%	9.8%
5039	CONSTRUCTION MATERIALS, NEC	9,068	18.7	38	261	1,776	0.9	7.4%	7.2%	8.6%	8.6%	8.7%	8.7%
5051	METALS SERVICE CENTERS & OFFICES	8,754	5.2	35	211	1,138	0.9	6.7%	6.5%	5.5%	5.5%	5.4%	5.4%
5074	PLUMBING AND HYDRONIC HEATING SUPPLES	7,955	9.3	35	194	1,054	0.7	7.0%	6.8%	6.8%	6.8%	7.0%	7.0%
5083	FARM MACHINERY, WHOLESALE	13,617	16.6	4	69	1,411	1.2	0.7%	0.5%	2.4%	2.4%	7.2%	7.2%
5084	INDUSTRIAL MACHINERY, WHOLESALE	23,413	6.7	39	185	689	0.9	7.5%	7.3%	6.0%	6.0%	3.3%	3.3%
5093	SCRAP AND WASTE MATERIALS	8,454	8.9	53	161	1,824	0.9	10.5%	10.3%	5.1%	5.0%	9.1%	9.1%
5141	GROCERIES, GENERAL	3,594	6.2	40	183	1,401	1.4	7.2%	6.9%	5.1%	5.0%	6.8%	6.8%
5143	DAIRY PRODUCTS	3,645	8.4	(37)	268	3,140	0.8	-6.2%	-6.3%	8.1%	8.1%	12.0%	12.0%
5148	FRESH FRUITS & VEGETABLES, WHOLSALE	5,176	5.6	62	198	1,122	1.0	11.7%	11.5%	7.1%	7.1%	6.5%	6.5%
5153	GRAIN	8,377	14.8	88	152	2,512	1.0	14.5%	14.4%	4.9%	4.9%	11.4%	11.4%
5161	CHEMICALS, WHOLESALERS	9,380	5.2	52	200	1,218	0.8	10.1%	10.0%	6.2%	6.2%	5.9%	5.9%
5171	PETROLEUM BULK STATIONS & TERMINALS	13,155	43.9	44	238	194	1.9	7.5%	7.1%	7.6%	7.5%	1.1%	1.1%
5172	PETROLEUM PRODUCTS, WHOLESALE	4,990	44.1	64	237	6,029	1.7	11.7%	11.4%	8.1%	8.1%	30.1%	30.1%
5181	BEER & ALE	4,483	25.7	42	268	2,265	1.3	7.5%	7.3%	8.0%	7.9%	12.0%	12.0%
5211	LUMBER, BUILDING MATERIALS DEALERS	24,268	12.3	42	198	1,405	0.8	8.0%	7.8%	6.6%	6.6%	7.1%	7.1%
5261	RETAIL NURSERIES & GARDEN STORES	7,162	19.4	25	127	--	0.9	5.7%	5.5%	5.0%	5.0%	--	--
5311	DEPARTMENT STORES	9,767	12.3	41	125	1,348	0.9	7.6%	7.4%	3.7%	3.6%	5.7%	5.7%
5451	DAIRY PRODUCT STORES	5,375	10.0	32	535	--	1.4	9.1%	8.7%	12.3%	12.3%	--	--
5531	AUTO & HOME SUPPLY STORES	39,071	5.0	26	139	2,296	0.8	6.5%	6.3%	5.5%	5.4%	11.0%	11.0%
7211	POWER LAUNDERIES	2,122	8.6	36	228	--	1.1	9.5%	9.2%	9.2%	9.2%	--	--
7213	LINEN SUPPLY	1,294	29.3	62	111	--	1.3	12.9%	12.6%	3.1%	3.1%	--	--
7261	FUNERAL SERVICES & CREMATORIES	14,951	5.0	30	66	--	0.7	8.6%	8.4%	2.3%	2.3%	--	--
7342	DISINFECTING AND EXTERMINATING	6,575	8.6	27	340	--	0.7	9.8%	9.6%	9.5%	9.5%	--	--
7391	RESEARCH & DEVELOPMENT LABORATORIES	2,717	5.9	35	439	1,773	1.4	7.3%	7.0%	13.0%	12.9%	6.8%	6.8%
7394	EQUIPMENT RENTAL & LEASING	15,594	10.4	48	338	722	1.2	11.0%	10.7%	10.5%	10.4%	3.6%	3.6%
7512	PASSENGER CAR RENTAL & LEASING	4,568	26.7	55	158	1,335	1.1	10.7%	10.5%	4.4%	4.3%	5.8%	5.8%
7692	WELDING REPAIR	4,411	8.1	42	408	--	0.6	11.1%	10.9%	12.2%	12.2%	--	--
7997	MEMBERSHIP SPORTS & RECREATION CLUBS	11,231	13.8	17	45	--	0.8	3.1%	3.0%	1.7%	1.7%	--	--

hibit 6.26

SCREENING ANALYSIS FOR NON-RETAIL PETROLEUM TANKS

Regulatory Costs of $5000/Tank

SIC	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of industry with tanks	Pretax profit per firm by firm size: Small	Medium	Large	UST costs per establishment	Pretax return on assets: Small Before	Small After	Medium Before	Medium After	Large Before	Large After
				($1000)	($1000)	($1000)	($1000)						
1311	CRUDE PETROLEUM & NATURAL GAS	8,712	54.3	109	241	418	9.0	21.1%	19.3%	4.9%	4.8%	1.7%	1.7%
1442	CONSTRUCTION SAND AND GRAVEL	2,270	54.8	32	207	--	14.8	6.3%	3.4%	7.2%	6.7%	--	--
1611	HIGHWAY AND STREET CONSTRUCTION	9,651	7.0	29	89	462	14.2	6.9%	3.5%	4.1%	3.5%	4.8%	4.7%
1761	ROOFING AND SHEET METAL WORK	17,487	5.1	24	72	--	7.8	9.0%	6.1%	5.9%	5.3%	--	--
1794	EXCAVATION AND FOUNDATION WORK	11,050	9.0	21	167	719	11.1	6.1%	2.8%	10.7%	10.0%	9.0%	8.9%
2011	MEAT PACKING PLANTS	1,689	42.0	25	529	1,755	11.2	4.0%	2.3%	12.3%	12.0%	7.7%	7.6%
2016	POULTRY DRESSING PLANTS	364	35.7	--	664	4,365	15.0	--	--	15.1%	14.8%	15.9%	15.9%
2033	CANNED FRUITS AND VEGETABLES	676	35.0	--	8	3,011	11.7	--	--	0.2%	-0.1%	12.0%	12.0%
2048	PREPARED FEEDS, NEC	1,767	39.6	(42)	360	1,950	12.2	-6.7%	-8.7%	10.7%	10.3%	8.5%	8.4%
2051	BREAD, CAKE AND RELATED PRODUCTS	2,112	21.9	33	426	1,703	13.0	8.7%	5.3%	9.6%	9.3%	8.6%	8.6%
2084	WINES, BRANDY AND SPIRITS	348	28.4	--	(16)	309	10.3	--	--	-0.4%	-0.7%	1.3%	1.3%
2086	BOTTLED AND CANNED SOFT DRINKS	1,547	93.3	25	463	2,400	10.2	5.1%	3.0%	10.4%	10.2%	9.5%	9.5%
2421	SAWMILLS & PLANING MILLS	5,531	34.3	39	299	177	13.6	7.2%	4.7%	9.0%	8.6%	0.7%	0.7%
2431	MILLWORK	2,121	6.9	52	430	3,610	11.0	10.1%	7.9%	13.4%	13.1%	19.6%	19.5%
2448	WOOD PALLETS & SKIDS	1,469	17.5	54	--	--	11.1	12.3%	9.7%	--	--	--	--
2621	PAPER MILLS, EXCEPT BUILDING PAPER	350	100.0	90	353	3,086	17.1	16.4%	13.3%	10.1%	9.6%	12.2%	12.1%
2711	NEWSPAPERS	8,223	6.3	42	277	2,599	13.1	8.3%	5.7%	7.3%	6.9%	12.1%	12.1%
2831	PHARMACEUTICAL PREPARATIONS	666	13.1	75	351	3,163	14.1	14.5%	11.7%	11.2%	10.8%	12.8%	12.8%
2851	PAINTS & ALLIED PRODUCTS	1,379	19.9	49	310	3,013	8.1	8.7%	7.3%	8.5%	8.2%	12.6%	12.6%
2861	INDUSTRIAL INORGANIC CHEMICALS, NEC	582	30.6	38	326	1,618	8.2	7.0%	5.5%	9.1%	8.9%	6.1%	6.1%
2911	PETROLEUM REFINING	460	53.1	--	1,202	3,741	13.8	--	--	32.7%	32.4%	17.1%	17.0%
3273	READY-MIXED CONCRETE	5,088	67.5	54	241	1,741	11.1	9.1%	7.2%	7.9%	7.6%	7.8%	7.8%
3312	BLAST FURNACES & STEEL MILLS	521	29.2	61	126	1,291	18.6	11.7%	8.1%	2.8%	2.4%	5.6%	5.6%
3321	GRAY IRON FOUNDRIES	867	44.4	63	148	623	10.0	14.0%	11.8%	4.0%	3.8%	2.9%	2.9%
3443	FABRICATED PLATEWORK	1,742	9.0	20	114	1,267	10.9	3.4%	1.5%	3.6%	3.3%	6.4%	6.4%
3444	SHEET METAL WORK	3,456	7.0	35	275	2,246	6.6	7.6%	6.2%	9.3%	9.1%	10.5%	10.5%
3523	FARM MACHINERY & EQUIPMENT	1,748	8.5	(9)	121	785	10.3	-1.7%	-3.5%	3.4%	3.1%	3.6%	3.5%
3662	RADIO & TV COMMUNICATION EQUIPMENT	2,059	5.5	1	288	2,632	19.6	0.2%	-3.7%	7.6%	7.1%	11.9%	11.8%
3671	SEMICONDUCTORS & RELATED DEVICES	89	9.3	73	381	3,135	7.2	13.6%	12.3%	10.7%	10.5%	13.3%	13.2%
3728	AIRCRAFT EQUIPMENT, NEC	849	9.7	43	301	--	22.3	7.2%	3.4%	8.7%	8.1%	--	--
3731	SHIP BUILDING & REPAIRING	616	23.9	(35)	189	(420)	15.0	-7.3%	-10.5%	5.0%	4.6%	-1.9%	-2.0%
4225	GENERAL WAREHOUSING AND STORAGE	2,284	26.2	45	547	--	7.7	9.4%	7.8%	14.9%	14.7%	--	--
4463	MARINE CARGO HANDLING	796	21.9	--	458	3,265	10.0	--	--	9.7%	9.5%	13.2%	13.2%
4811	TELEPHONE COMMUNICATION	13,124	42.1	104	328	3,309	9.6	20.9%	19.0%	10.0%	9.7%	13.9%	13.9%
4953	REFUSE SYSTEMS	4,251	35.8	821	228	--	14.4	188.3%	185.0%	9.5%	8.9%	--	--

Exhib. .26 (Continued)

SCREENING ANALYSIS FOR NON-RETAIL PETROLEUM TANKS

Regulatory Costs of $5000/Tank

	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of industry with tanks	Pretax profit per firm by firm size			UST costs per establishment	Pretax return on assets					
				Small	Medium	Large		Small		Medium		Large	
				($1000)			($1000)	Before	After	Before	After	Before	After
5012	AUTOMOBILES & OTHER MOTOR VEHICLES	5,829	5.2	49	268	3,342	8.6	8.4%	7.0%	8.4%	8.2%	16.3%	16.3%
5031	LUMBER, PLYWOOD & MILLWORK	6,889	9.6	58	303	1,893	9.2	10.6%	8.9%	9.4%	9.1%	9.8%	9.8%
5039	CONSTRUCTION MATERIALS, NEC	9,068	18.7	38	261	1,776	9.2	7.4%	5.6%	8.6%	8.3%	8.7%	8.6%
5051	METALS SERVICE CENTERS & OFFICES	8,754	5.2	35	211	1,138	8.7	6.7%	5.0%	5.5%	5.3%	5.4%	5.3%
5074	PLUMBING AND HYDRONIC HEATING SUPPLIES	7,955	9.3	35	194	1,054	6.6	7.0%	5.7%	6.8%	6.6%	7.0%	7.0%
5083	FARM MACHINERY, WHOLESALE	13,617	16.6	4	69	1,411	11.7	0.7%	-1.5%	2.4%	2.0%	7.2%	7.2%
5084	INDUSTRIAL MACHINERY, WHOLESALE	23,413	6.7	39	185	689	9.1	7.5%	5.7%	6.0%	5.7%	3.3%	3.3%
5093	SCRAP AND WASTE MATERIALS	8,454	8.9	53	161	1,824	9.1	10.5%	8.7%	5.1%	4.8%	9.1%	9.1%
5141	GROCERIES, GENERAL	3,594	6.2	40	183	1,401	13.6	7.2%	4.8%	5.1%	4.7%	6.8%	6.7%
5143	DAIRY PRODUCTS	3,645	8.4	(37)	268	3,140	8.2	-6.2%	-7.6%	8.1%	7.9%	12.0%	12.0%
5148	FRESH FRUITS & VEGETABLES, WHOLSALE	5,176	5.6	62	198	1,122	10.3	11.7%	9.7%	7.1%	6.8%	6.5%	6.4%
5153	GRAIN	8,377	14.8	88	152	2,512	9.8	14.5%	12.9%	4.9%	4.6%	11.4%	11.3%
5161	CHEMICALS, WHOLESALERS	9,380	5.2	52	200	1,218	8.3	10.1%	8.5%	6.2%	6.0%	5.9%	5.9%
5171	PETROLEUM BULK STATIONS & TERMINALS	13,155	43.9	44	238	194	18.7	7.5%	4.3%	7.6%	7.0%	1.1%	1.0%
5172	PETROLEUM PRODUCTS, WHOLESALE	4,990	44.1	64	237	6,029	17.3	11.7%	8.5%	8.1%	7.6%	30.1%	30.0%
5181	BEER & ALE	4,483	25.7	42	268	2,265	12.8	7.5%	5.3%	8.0%	7.6%	12.0%	11.9%
5211	LUMBER, BUILDING MATERIALS DEALERS	24,268	12.3	42	198	1,405	8.4	8.0%	6.4%	6.6%	6.3%	7.1%	7.1%
5261	RETAIL NURSERIES & GARDEN STORES	7,162	19.4	25	127	--	8.8	5.7%	3.7%	5.0%	4.7%	--	--
5311	DEPARTMENT STORES	9,767	12.3	41	125	1,348	9.1	7.6%	5.9%	3.7%	3.4%	5.7%	5.7%
5451	DAIRY PRODUCT STORES	5,375	10.0	32	535	--	14.5	9.1%	4.9%	12.3%	12.0%	--	--
5531	AUTO & HOME SUPPLY STORES	39,071	5.0	26	139	2,296	7.7	6.5%	4.6%	5.5%	5.2%	11.0%	11.0%
7211	POWER LAUNDERIES	2,122	8.6	36	228	--	10.7	9.5%	6.7%	9.2%	8.8%	--	--
7213	LINEN SUPPLY	1,294	29.3	62	111	--	12.6	12.9%	10.2%	3.1%	2.8%	--	--
7261	FUNERAL SERVICES & CREMATORIES	14,951	5.0	30	66	--	6.9	8.6%	6.6%	2.3%	2.1%	--	--
7342	DISINFECTING AND EXTERMINATING	6,575	8.6	27	340	--	7.0	9.8%	7.3%	9.5%	9.3%	--	--
7391	RESEARCH & DEVELOPMENT LABORATORIES	2,717	5.9	35	439	1,773	14.4	7.3%	4.3%	13.0%	12.5%	6.8%	6.8%
7394	EQUIPMENT RENTAL & LEASING	15,594	10.4	48	338	722	12.2	11.0%	8.1%	10.5%	10.1%	3.6%	3.5%
7512	PASSENGER CAR RENTAL & LEASING	4,568	26.7	55	158	1,335	10.7	10.7%	8.6%	4.4%	4.1%	5.8%	5.7%
7692	WELDING REPAIR	4,411	8.1	42	408	--	5.8	11.1%	9.6%	12.2%	12.1%	--	--
7997	MEMBERSHIP SPORTS & RECREATION CLUBS	11,231	13.8	17	45	--	7.9	3.1%	1.7%	1.7%	1.4%	--	--

Regulatory Costs of $50,000/Tank

SIC	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of industry with tanks	Pretax profit per firm by firm size ($1000)			UST costs per establishment ($1000)	Pretax return on assets					
								Small		Medium		Large	
				Small	Medium	Large		Before	After	Before	After	Before	After
1311	CRUDE PETROLEUM & NATURAL GAS	8,712	54.3	109	241	418	89.6	21.1%	3.8%	4.9%	3.1%	1.7%	1.4%
1442	CONSTRUCTION SAND AND GRAVEL	2,270	54.8	32	207	--	148.2	6.3%	-22.6%	7.2%	2.0%	--	--
1611	HIGHWAY AND STREET CONSTRUCTION	9,651	7.0	29	89	462	142.4	6.9%	-26.9%	4.1%	-2.5%	4.8%	3.3%
1761	ROOFING AND SHEET METAL WORK	17,487	5.1	24	72	--	77.8	9.0%	-19.7%	5.9%	-0.5%	--	--
1794	EXCAVATION AND FOUNDATION WORK	11,050	9.0	21	167	719	110.9	6.1%	-26.4%	10.7%	3.6%	9.0%	7.6%
2011	MEAT PACKING PLANTS	1,689	42.0	25	529	1,755	111.8	4.0%	-13.7%	12.3%	9.7%	7.7%	7.2%
2016	POULTRY DRESSING PLANTS	364	35.7	--	664	4,365	150.0	--	--	15.1%	11.7%	15.9%	15.4%
2033	CANNED FRUITS AND VEGETABLES	676	35.0	--	8	3,011	117.4	--	--	0.2%	-3.1%	12.0%	11.5%
2048	PREPARED FEEDS, NEC	1,767	39.6	(42)	360	1,950	121.6	-6.7%	-26.3%	10.7%	7.1%	8.5%	7.9%
2051	BREAD, CAKE AND RELATED PRODUCTS	2,112	21.9	33	426	1,703	130.0	8.7%	-25.2%	9.6%	6.7%	8.6%	8.0%
2084	WINES, BRANDY AND SPIRITS	348	28.4	--	(16)	309	103.2	--	--	-0.4%	-3.1%	1.3%	0.9%
2086	BOTTLED AND CANNED SOFT DRINKS	1,547	93.3	25	463	2,400	102.4	5.1%	-15.4%	10.4%	8.1%	9.5%	9.1%
2421	SAWMILLS & PLANING MILLS	5,531	34.3	39	299	177	136.5	7.2%	-18.3%	9.0%	4.9%	0.7%	0.2%
2431	MILLWORK	2,121	6.9	52	430	3,610	109.5	10.1%	-11.3%	13.4%	10.0%	19.6%	19.0%
2448	WOOD PALLETS & SKIDS	1,469	17.5	54	--	--	110.7	12.3%	-13.1%	--	--	--	--
2621	PAPER MILLS, EXCEPT BUILDING PAPER	350	100.0	90	353	3,086	170.8	16.4%	-14.9%	10.1%	5.2%	12.2%	11.5%
2711	NEWSPAPERS	8,223	6.3	42	277	2,599	131.3	8.3%	-17.9%	7.3%	3.8%	12.1%	11.5%
2831	PHARMACEUTICAL PREPARATIONS	666	13.1	75	351	3,163	140.9	14.5%	-12.7%	11.2%	6.7%	12.8%	12.2%
2851	PAINTS & ALLIED PRODUCTS	1,379	19.9	49	310	3,013	81.3	8.7%	-5.6%	8.5%	6.3%	12.6%	12.3%
2861	INDUSTRIAL INORGANIC CHEMICALS, NEC	582	30.6	38	326	1,618	81.6	7.0%	-8.1%	9.1%	6.9%	6.1%	5.8%
2911	PETROLEUM REFINING	460	53.1	--	1,202	3,741	138.2	--	--	32.7%	29.0%	17.1%	16.5%
3273	READY-MIXED CONCRETE	5,088	67.5	54	241	1,741	110.5	9.1%	-9.5%	7.9%	4.3%	7.8%	7.3%
3312	BLAST FURNACES & STEEL MILLS	521	29.2	61	126	1,291	185.7	11.7%	-24.2%	2.8%	-1.3%	5.6%	4.8%
3321	GRAY IRON FOUNDRIES	867	44.4	63	148	623	100.0	14.0%	-8.3%	4.0%	1.3%	2.9%	2.5%
3443	FABRICATED PLATEWORK	1,742	9.0	20	114	1,267	109.4	3.4%	-14.9%	3.6%	0.1%	6.4%	5.9%
3444	SHEET METAL WORK	3,456	7.0	35	275	2,246	66.2	7.6%	-6.7%	9.3%	7.0%	10.5%	10.2%
3523	FARM MACHINERY & EQUIPMENT	1,748	8.5	(9)	121	785	103.1	-1.7%	-20.5%	3.4%	0.5%	3.6%	3.1%
3662	RADIO & TV COMMUNICATION EQUIPMENT	2,059	5.5	1	288	2,632	196.4	0.2%	-38.9%	7.6%	2.4%	11.9%	11.0%
3671	SEMICONDUCTORS & RELATED DEVICES	89	9.3	73	381	3,135	72.0	13.6%	0.2%	10.7%	8.7%	13.3%	12.9%
3728	AIRCRAFT EQUIPMENT, NEC	849	9.7	43	301	--	223.2	7.2%	-30.4%	8.7%	2.2%	--	--
3731	SHIP BUILDING & REPAIRING	616	23.9	(35)	189	(420)	150.0	-7.3%	-39.2%	5.0%	1.0%	-1.9%	-2.6%
4225	GENERAL WAREHOUSING AND STORAGE	2,284	26.2	45	547	--	76.6	9.4%	-6.5%	14.9%	12.8%	--	--
4463	MARINE CARGO HANDLING	796	21.9	--	458	3,265	100.0	--	--	9.7%	7.6%	13.2%	12.8%
4811	TELEPHONE COMMUNICATION	13,124	42.1	104	328	3,309	95.9	20.9%	1.6%	10.0%	7.1%	13.9%	13.5%
4953	REFUSE SYSTEMS	4,251	35.8	821	228	--	143.8	188.3%	155.3%	9.5%	3.5%	--	--

Exh 6.27 (Continued)

SCREENING ANALYSIS FOR NON-RETAIL PETROLEUM TANKS

Regulatory Costs of $50,000/Tank

SIC	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of industry with tanks	Pretax profit per firm by firm size: Small ($1000)	Medium ($1000)	Large ($1000)	UST costs per establishment ($1000)	Pretax return on assets: Small Before	Small After	Medium Before	Medium After	Large Before	Large After
5012	AUTOMOBILES & OTHER MOTOR VEHICLES	5,829	5.2	49	268	3,342	86.0	8.4%	-6.3%	8.4%	5.7%	16.3%	15.9%
5031	LUMBER, PLYWOOD & MILLWORK	6,889	9.6	58	303	1,893	91.7	10.6%	-6.2%	9.4%	6.6%	9.8%	9.4%
5039	CONSTRUCTION MATERIALS, NEC	9,068	18.7	38	261	1,776	92.2	7.4%	-10.5%	8.6%	5.6%	8.7%	8.2%
5051	METALS SERVICE CENTERS & OFFICES	8,754	5.2	35	211	1,138	87.0	6.7%	-9.8%	5.5%	3.3%	5.4%	4.9%
5074	PLUMBING AND HYDRONIC HEATING SUPPLES	7,955	9.3	35	194	1,054	66.2	7.0%	-6.1%	6.8%	4.5%	7.0%	6.6%
5083	FARM MACHINERY, WHOLESALE	13,617	16.6	4	69	1,411	117.1	0.7%	-21.1%	2.4%	-1.7%	7.2%	6.6%
5084	INDUSTRIAL MACHINERY, WHOLESALE	23,413	6.7	39	185	689	90.5	7.5%	-10.0%	6.0%	3.1%	3.3%	2.9%
5093	SCRAP AND WASTE MATERIALS	8,454	8.9	53	161	1,824	90.8	10.5%	-7.4%	5.1%	2.2%	9.1%	8.6%
5141	GROCERIES, GENERAL	3,594	6.2	40	183	1,401	135.9	7.2%	-17.2%	5.1%	1.3%	6.8%	6.1%
5143	DAIRY PRODUCTS	3,645	8.4	(37)	268	3,140	81.7	-6.2%	-20.1%	8.1%	5.7%	12.0%	11.7%
5148	FRESH FRUITS & VEGETABLES, WHOLSALE	5,176	5.6	62	198	1,122	102.9	11.7%	-7.7%	7.1%	3.4%	6.5%	5.9%
5153	GRAIN	8,377	14.8	88	152	2,512	97.6	14.5%	-1.6%	4.9%	1.8%	11.4%	10.9%
5161	CHEMICALS, WHOLESALERS	9,380	5.2	52	200	1,218	83.0	10.1%	-6.1%	6.2%	3.7%	5.9%	5.5%
5171	PETROLEUM BULK STATIONS & TERMINALS	13,155	43.9	44	238	194	187.0	7.5%	-24.3%	7.6%	1.6%	1.1%	0.0%
5172	PETROLEUM PRODUCTS, WHOLESALE	4,990	44.1	64	237	6,029	173.2	11.7%	-20.2%	8.1%	2.2%	30.1%	29.2%
5181	BEER & ALE	4,483	25.7	42	268	2,265	127.5	7.5%	-15.3%	8.0%	4.2%	12.0%	11.3%
5211	LUMBER, BUILDING MATERIALS DEALERS	24,268	12.3	42	198	1,405	83.6	8.0%	-8.0%	6.6%	3.8%	7.1%	6.7%
5261	RETAIL NURSERIES & GARDEN STORES	7,162	19.4	25	127	--	87.8	5.7%	-14.2%	5.0%	1.6%	--	--
5311	DEPARTMENT STORES	9,767	12.3	41	125	1,348	90.6	7.6%	-9.3%	3.7%	1.0%	5.7%	5.4%
5451	DAIRY PRODUCT STORES	5,375	10.0	32	535	--	144.5	9.1%	-32.2%	12.3%	9.0%	--	--
5531	AUTO & HOME SUPPLY STORES	39,071	5.0	26	139	2,296	76.6	6.5%	-12.4%	5.5%	2.5%	11.0%	10.6%
7211	POWER LAUNDERIES	2,122	8.6	36	228	--	107.1	9.5%	-18.6%	9.2%	4.9%	--	--
7213	LINEN SUPPLY	1,294	29.3	62	111	--	126.1	12.9%	-13.5%	3.1%	-0.4%	--	--
7261	FUNERAL SERVICES & CREMATORIES	14,951	5.0	30	66	--	68.6	8.6%	-11.1%	2.3%	-0.1%	--	--
7342	DISINFECTING AND EXTERMINATING	6,575	8.6	27	340	--	70.3	9.8%	-15.6%	9.5%	7.5%	--	--
7391	RESEARCH & DEVELOPMENT LABORATORIES	2,717	5.9	35	439	1,773	143.9	7.3%	-22.3%	13.0%	8.7%	6.8%	6.3%
7394	EQUIPMENT RENTAL & LEASING	15,594	10.4	48	338	722	122.2	11.0%	-17.2%	10.5%	6.7%	3.6%	3.0%
7512	PASSENGER CAR RENTAL & LEASING	4,568	26.7	55	158	1,335	106.7	10.7%	-10.2%	4.4%	1.4%	5.8%	5.3%
7692	WELDING REPAIR	4,411	8.1	42	408	--	58.1	11.1%	-4.2%	12.2%	10.5%	--	--
7997	MEMBERSHIP SPORTS & RECREATION CLUBS	11,231	13.8	17	45	--	79.1	3.1%	-11.4%	1.7%	-1.3%	--	--

be roughly $5,000 per tank, assuming a baseline tank replacement program already exists. For purposes of this screening analysis, incremental corrective action costs are assigned to be an order of magnitude higher than tank replacement, or $50,000 per tank. However, the probability of having to undergo tank replacement or corrective action varies over regulatory options. In addition, the expected cost of tank replacement and corrective action varies over regulatory options.

For each SIC code in each exhibit, the following information is presented:

- Number of establishments in SIC code (includes all establishments nationwide, not just those with USTs);
- Percentage of establishments with nonretail petroleum USTs;
- Pre-tax profits for three size classes of firm:
  - small: less than $1 million in assets
  - medium: $1-10 million in assets
  - large: $10-50 million in assets;
- Costs per establishment: the number of tanks per establishment times the assumed regulatory cost per tank;
- Return on assets (before regulatory costs): presented for three size classes, based on data in Robert Morris statement studies; and
- Return on assets (after regulatory costs): presented for three size classes after adjusting for regulatory costs.

<u>Determine which Industries Show Potential for Significant Economic Impacts</u>

As explained in Section 6.B, return on assets (ROA) was selected as the measure to assess viability because expected ROA is reasonably consistent across industries and size classes. An ROA of less than -30 percent is interpreted as certain failure, while an ROA between -4 percent and -30 percent is characterized as severe financial distress.

Note that this screening analysis only examines indicators of potential impacts. It does not attempt to determine whether the costs of meeting the regulations are passed on to consumers of the facility, or passed "backwards" to suppliers of the facility. Either or both of these can occur under some competitive conditions, resulting in insignificant impacts on profits even if regulatory costs appear high relative to profits. This is one of the limitations of a screening analysis.

In addition, as stated earlier, many industries would presumably have alternatives to using nonretail petroleum USTs. This would include purchase of motor fuels at retail. The existence of this alternative tends to mitigate the potential for adverse economic effects, although corrective action responsibility for existing releases cannot be avoided by switching from USTs.

6.C.2. Results and Analysis

Exhibits 6.25, 6.26, and 6.27 provide data on the effect of regulatory costs of $500, $5,000, and $50,000 per tank on return on assets for small, medium, and large firms in 4-digit SIC codes where more than 5% of the establishments maintain USTs for non-retail petroleum storage. Exhibit 6.25 shows that regulatory costs of $500 per tank do not affect return on assets to any significant extent for small, medium, or large firms. Therefore, it seems likely that regulatory costs of this magnitude will not create the potential for significant economic dislocation among firms using non-retail petroleum USTs. Similarly, regulatory costs of $5,000 per tank do not seem likely to create the potential for significant economic dislocation for the same reasons as stated above--returns on assets are not significantly affected by costs of this magnitude.

In contrast, Exhibit 6.8 shows that regulatory costs of $50,000 per tank will move almost all small businesses in the SIC codes examined into the severe financial distress or certain closure category. However this finding must be tempered by the following observations:

- Non-retail petroleum USTs are maintained in only a fraction of the establishments within the industries affected. In addition, it is likely that larger establishments would be more likely to maintain USTs than smaller establishments, so the extent to which small businesses are actually affected is not clear.

- Not all establishments with non-retail petroleum USTs will need to undertake corrective actions. It can probably be assumed that only those establishments with existing leaks will incur corrective action costs. Furthermore, not all of these costs are attributable to to the regulatory alternatives under consideration, as some corrective action for existing releases will be performed even in the absence of the promulgation of federal requirements.

Thus, although regulatory costs of $50,000 per tank are clearly significant, the likelihood that small firms will have to incur such costs as a result of rules promulgated by EPA is unclear.

With respect to medium firms, it seems likely that regulatory costs of $50,000 per tank will potentially weaken a significant number of firms, although their viability does not seem to be threatened in the short-run. Return on assets remains positive for most medium firms in Exhibit 6.8, although seven of the 65 SIC codes listed go slightly negative. None of these reach a level which can be termed severe financial distress, however. As with small firms, questions of UST incidence among medium firms and probabilities of having to undertake corrective action are pertinent. Also pertinent is the possibility that corrective action could cost considerably more than $50,000.

Return on assets for large firms seems relatively unaffected by regulatory costs of $50,000 per tank. However, USTs per establishment were assumed not to vary over size category, even though it is possible that large firms have more tanks per establishment than smaller firms. It is also possible that large firms maintain multiple establishments, thus making them more susceptible to corrective actions from existing releases. Given that corrective action costs can significantly exceed $50,000, corrective action could produce significant economic dislocation even among larger firms.

6.C.3. Limitations of the Analysis

- The data on compliance costs are based on costs incurred by facilities, but the financial data describes firms.

The California data are on the number of tanks and number of facilities. But the financial data by industry are on a corporate basis, i.e., tax filers or loan applicants. It is highly likely that even the smallest size category (asset size up to $1 million) includes some firms with more than one facility or more than one tank site. The larger categories for many industries almost certainly represent multiple site facilities. Therefore, regulatory costs for larger firms may be understated.

- SIC codes may not categorize the industries in an optimal manner for this analysis.

The SIC code of a firm is that representing the largest component of its net sales, but many firms practice a mix of industrial activities. This can include a mix in type of products involved, and/or a mix between manufacturing, wholesaling, retailing, and providing services. As a result, the SIC code that describes the principal activity of a firm may not be the one describing the activity for which tanks are used. Thus, regulatory costs are assigned to SIC codes based on tank use patterns by establishments while financial statistics are assigned to SIC codes by the principal activity of firms. Such a limitation is not thought to create a consistent bias, however.

- The number of tanks per firm may vary with firm size.

In calculating the multiple tank costs, we have assumed that for all asset size ranges, each firm owns the industry average number of tanks. For this reason, the regulatory costs relative to profits are largest for the smallest firms. If in fact the smaller firms have fewer tanks, which is likely to be the case in some industries, the regulatory burden on those firms may be relatively less. Thus, the screening study may overstate impacts on relatively small businesses in each industry category.

- Industrial patterns in California may not be typical of the United States.

California data are used to determine which industries own tanks, the percent of firms in each industry that own tanks, and the number of tanks per firm. Because of age of firms; locations relative to suppliers, pipelines, or transportation; the mix of industries, and other factors, these data may not be typical of other regions of the country. For example some industries that are (are not) prevalent in California or that operate with (without) underground tanks may be different in other states. No other data were available to test the degree to which California's use of underground tanks is typical. Consequently, the screening analysis is a rough indicator or potentially affected industries.

o Existing releases may vary by firm size.

The likelihood of being liabile for corrective action costs is a function of whether or not USTs are currently leaking. Because baseline detection and replacement policies may differ by firm size, it is not clear whether the likelihood of an existing release is independent of firm size.

o Because of the different sources used, results should be viewed as approximate.

The percent of firms in the industry with tanks is a ratio of numbers derived from a recent California tank registry and from the 1982 County Business Patterns. Financial statistics are from a source compiled from 1985 data. It is possible that different economic conditions in the different periods produce results different than synchronous observations; and that firms and facilities are classified into SIC codes using different criteria among the sources. Nevertheless, the ranking and general magnitude of results should not be significantly affected.

o A screening measure does not estimate impacts.

This screening measure is designed to identify those industries for which the compliance costs are large enough relative to corporate profits that the economic impacts could be significant if they were completely absorbed out of profits. Some impacted firms may be able to pass the costs on--in part or in total--to their customers or to their suppliers. In this case, the few industries identified in this analysis as showing potential for significant economic impacts may in fact experience insignificant impacts. The likelihood for this to occur depends on the degree of competition among firms in the affected industries. The extent to which firms will incur the larger costs of tank replacement and corrective action vary with each regulatory alternative. Modelling these alternative-specific impacts for the large number of SIC codes potentially affected was beyond the scope of this analysis.

6.C.4. Sources of Information

The following sources of information were used in writing this section of the RIA:

o SIC Industries with large numbers of USTs:

Data Resources, Inc. and Quantum Analytics, Inc., for U.S. Environmental Protection Agency; Draft Report: Underground Storage Tanks Technical Data Collection; October 24, 1985. October 24, 1985, Appendix D.

California data includes SIC code, number of facilities with tanks, and number of tanks. SCI calculated the number of tanks per facility with tanks as the ratio of the latter two.

o Number of facilities in California within each SIC industry group:

U.S. Department of Commerce, Bureau of the Census; County Business Patterns, 1982: California; CBP-82-6. pp. 1-16.

SCI calculated the percentage of facilities in each SIC code with tanks by dividing the number of facilities with tanks by the number of facilities in the state.

o Financial Data by SIC Code:

Robert Morris Associates; '85 Annual Statement Studies; Philadelphia, PA; September 1985.

For samples of varying sizes, provides (among other data) total assets, net sales, and the ratios of various expense and profit categories to net sales. SCI calculated absolute values per firm in the sample from the sample aggregates and from the ratios.

6.D. IMPACTS ON FIRMS USING USTs FOR CHEMICALS STORAGE

6.D.1. Methodology

The methodology used for the chemical UST screening analysis is identical to that used for the nonretail petroleum UST screening study. The ten four-digit SIC industries identified as owning the greatest number of chemical tanks are:

2819	Industrial inorganic chemicals, NEC
2821	Plastics materials and resins
2851	Paints and allied products
2869	Industrial organic chemicals, NEC
2899	Chemical preparations, NEC
3471	Plating and polishing
5161	Chemical Wholesalers
5171	Petroleum Bulk Stations and Terminals
5172	Petroleum Product Whole Salers
7216	Drycleaning Plants

The estimation of the fraction of each industry owning tanks reveals that even for those industries in which chemical tanks are most prevalent, they are far from universal. The precent of the industry owning USTs for chemicals storage ranges from 40 percent (paint and allied products) to one percent (drycleaning). Another difference in ownership patterns between chemical and petroleum tanks is that in some industries the average number of tanks (in facilities that actually have tanks) is much higher. For chemical tanks, the value ranges from thirteen tanks per facility (large paint facilities) to one (petroleum product wholesaler). Substitutes for underground chemical tanks include above-ground tanks, drums (especially for small businesses) and process changes. As one example of a process change, a switch from oil-based paint to water-based paint eliminates the need for solvents, which are the chemicals generally stored in underground tanks at paint producing facilities. As another example, underground chemical tanks at petroleum bulk stations generally include additives for gasoline. These could be blended in at an earlier point in the distribution chain. The existence of such substitutes tends to mitigate the potential economic effects of regulations for underground chemical tanks. However, corrective action responsibilities for existing tanks cannot be avoided by switching to substitutes, so corrective action requirements pose some potential for economic dislocation.

6.D.2. Results and Analysis

The analysis for chemical tanks was performed in the same manner as the analysis for petroleum tanks, but using the ten industries identified in the data base as owning the largest number of underground chemical tanks.

Three exhibits are provided:

- o Exhibit 6.28 at $500/tank (approximates detection);
- o Exhibit 6.29 at $5,000/tank (approximates replacement); and
- o Exhibit 6.30 at $50,000/tank (approximates corrective action).

Exhibit 6.28

SCREENING ANALYSIS FOR UNDERGROUND CHEMICAL TANKS

Regulatory Costs of $500/Tank

	SIC INDUSTRY GROUP	Number of establishments (all sizes)	Percent of firms with chemical tanks	Pretax profit per firm: Small	Medium	Large	UST costs per establishment	Pretax return on assets: Small Before	Small After	Medium Before	Medium After	Large Before	Large After
				($1000)	($1000)	($1000)	($1000)						
		(a)	(b)			(b)							
2819	INDUSTRIAL INORGANIC CHEMICALS, NEC	622	16	38	326	1,618	1.3	7.0%	6.8%	9.1%	9.1%	6.1%	6.1%
2821	PLASTIC MATERIALS & SYNTHETIC RESINS	518	31	131	312	2,160	1.6	22.3%	22.0%	9.1%	9.1%	11.8%	11.8%
2851	PAINTS & ALLIED PRODUCTS	1,379	40	49	310	3,103	2.8	8.7%	8.2%	8.5%	8.4%	13.0%	13.0%
2869	INDUSTRIAL ORGANIC CHEMICALS, NEC	582	20	38	326	1,618	1.8	7.0%	6.7%	9.1%	9.1%	6.1%	6.1%
2899	CHEMICAL PREPARATIONS, NEC	1,309	15	38	326	1,618	1.9	7.0%	6.7%	9.1%	9.1%	6.1%	6.1%
3471	PAINTING & POLISHING	3,156	7	53	381	--	2.1	11.2%	10.7%	13.5%	13.5%	--	--
5161	CHEMICALS, WHOLESALERS	9,380	3	52	200	1,218	5.1	10.2%	9.2%	6.2%	6.1%	5.9%	5.9%
5171	PETROLEUM BULK STATIONS & TERMINALS	13,155	9	44	238	1,937	1.9	7.5%	7.1%	7.6%	7.5%	8.1%	8.1%
5172	PETROLEUM PRODUCTS, WHOLESALE	4,990	8	64	237	6,029	0.7	11.8%	11.7%	8.2%	8.1%	30.1%	30.1%
7216	DRYCLEANING, EXCEPT RUGS	18,293	1	41	228	--	1.0	10.8%	10.5%	9.2%	9.2%	--	--

(a) Estimate of all establishments in each SIC code (not just those with chemical tanks).
SOURCE: County Business Patterns in the US, 1982

(b) SOURCE: Screening Study for Regulatory Impacts of UST Regulations, Appendix, March 31, 1986.

Exhibit 6.29

SCREENING ANALYSIS FOR UNDERGROUND CHEMICAL TANKS

Regulatory Costs of $5000/Tank

SIC	SIC INDUSTRY GROUP	Number of establishments (all sizes) (a)	Percent of firms with chemical tanks (b)	Pretax profit per firm by firm size (b) ($1000) Small	Medium	Large	UST costs per establishment ($1000)	Pretax return on assets: Small Before	Small After	Medium Before	Medium After	Large Before	Large After
2819	INDUSTRIAL INORGANIC CHEMICALS, NEC	622	16	38	326	1,618	13.0	7.0%	4.6%	9.1%	8.8%	6.1%	6.1%
2821	PLASTIC MATERIALS & SYNTHETIC RESINS	518	31	131	312	2,160	16.0	22.3%	19.6%	9.1%	8.7%	11.8%	11.7%
2851	PAINTS & ALLIED PRODUCTS	1,379	40	49	310	3,103	27.5	8.7%	3.8%	8.5%	7.7%	13.0%	12.9%
2869	INDUSTRIAL ORGANIC CHEMICALS, NEC	582	20	38	326	1,618	17.5	7.0%	3.8%	9.1%	8.7%	6.1%	6.1%
2899	CHEMICAL PREPARATIONS, NEC	1,309	15	38	326	1,618	18.5	7.0%	3.6%	9.1%	8.6%	6.1%	6.1%
3471	PAINTING & POLISHING	3,156	7	53	381	--	20.5	11.2%	6.9%	13.5%	12.8%	--	--
5161	CHEMICALS, WHOLESALERS	9,380	3	52	200	1,218	50.5	10.2%	0.3%	6.2%	4.7%	5.9%	5.7%
5171	PETROLEUM BULK STATIONS & TERMINALS	13,155	9	44	238	1,937	18.7	7.5%	4.3%	7.6%	7.0%	8.1%	8.0%
5172	PETROLEUM PRODUCTS, WHOLESALE	4,990	8	64	237	6,029	7.0	11.8%	10.5%	8.2%	7.9%	30.1%	30.1%
7216	DRYCLEANING, EXCEPT RUGS	18,293	1	41	228	--	10.0	10.8%	8.2%	9.2%	8.8%	--	--

(a) Estimate of all establishments in each SIC code (not just those with chemical tanks).
SOURCE: County Business Patterns in the US, 1982

(b) SOURCE: Screening Study for Regulatory Impacts of UST Regulations, Appendix, March 31, 1986.

Exhibit 6.30

SCREENING ANALYSIS FOR UNDERGROUND CHEMICAL TANKS

Regulatory Costs of $50,000/Tank

SIC	SIC INDUSTRY GROUP	Number of establishments (all sizes) (a)	Percent of firms with chemical tanks (b)	Pretax profit per firm by firm size (b) Small ($1000)	Medium ($1000)	Large ($1000)	UST costs per establishment ($1000)	Pretax return on assets: Small Before	Small After	Medium Before	Medium After	Large Before	Large After
2819	INDUSTRIAL INORGANIC CHEMICALS, NEC	622	16	38	326	1,618	130.0	7.0%	-17.0%	9.1%	5.5%	6.1%	5.6%
2821	PLASTIC MATERIALS & SYNTHETIC RESINS	518	31	131	312	2,160	160.0	22.3%	-4.9%	9.1%	4.4%	11.8%	10.9%
2851	PAINTS & ALLIED PRODUCTS	1,379	40	49	310	3,103	275.0	8.7%	-39.9%	8.5%	1.0%	13.0%	11.8%
2869	INDUSTRIAL ORGANIC CHEMICALS, NEC	582	20	38	326	1,618	175.0	7.0%	-25.3%	9.1%	4.2%	6.1%	5.5%
2899	CHEMICAL PREPARATIONS, NEC	1,309	15	38	326	1,618	185.0	7.0%	-27.2%	9.1%	4.0%	6.1%	5.4%
3471	PAINTING & POLISHING	3,156	7	53	381	--	205.0	11.2%	-32.1%	13.5%	6.3%	--	--
5161	CHEMICALS, WHOLESALERS	9,380	3	52	200	1,218	505.0	10.2%	-88.9%	6.2%	-9.5%	5.9%	3.5%
5171	PETROLEUM BULK STATIONS & TERMINALS	13,155	9	44	238	1,937	187.0	7.5%	-24.3%	7.6%	1.6%	8.1%	7.3%
5172	PETROLEUM PRODUCTS, WHOLESALE	4,990	8	64	237	6,029	70.0	11.8%	-1.1%	8.2%	5.8%	30.1%	29.7%
7216	DRYCLEANING, EXCEPT RUGS	18,293	1	41	228	--	100.0	10.8%	-15.5%	9.2%	5.2%	--	--

(a) Estimate of all establishments in each SIC code (not just those with chemical tanks).
SOURCE: County Business Patterns in the US, 1982

(b) SOURCE: Screening Study for Regulatory Impacts of UST Regulations, Appendix, March 31, 1986.

Our principal conclusion from this analysis is similar to the previously presented screening analysis of non-retail petroleum USTs. Regulatory costs of $500 per tank do not significantly affect return on assets for any size category in any of the ten SIC codes analyzed. Regulatory costs of $5,000 per tank do not appear to bring any firms to the point of severe financial distress or closure, but do weaken smaller firms somewhat. Regulatory costs of $50,000 per tank will cause many small firms to close, will weaken medium firms, and will only marginally affect larger firms. There are questions still to be addressed regarding the likelihood of firms of each size class incurring costs of this magnitude.

6.D.3. Limitations of the Analysis

The limitations of the screening analysis for chemical tanks are the same as those for petroleum product tanks, described above.

6.D.4. Sources of Information

The sources of information for the screening analysis for chemical tanks are the same as those for petroleum product tanks, described above.

Chapter 7

BENEFITS OF UST TECHNICAL STANDARDS AND REGULATIONS

7.A. INTRODUCTION

In Chapter 5, the costs of requirements for prevention and detection and costs for corrective action under each UST regulatory option were examined. Chapter 5 also looked at the effectiveness of each option in terms of the trade-offs between compliance costs and aggregate plume acreage of releases. In addition to cost-effectiveness, Executive Order 12291 directs agencies to quantify and monetize benefits to the extent possible and examine the trade-offs between benefits and costs for the various options considered in the RIA. The objective of this chapter is to develop estimates of aggregate benefits resulting from UST requirements under each option when compared to the base-case scenario.

To measure benefits, the EPA Guidelines for Performing Regulatory Impact Analyses recommends that one examine the following chain of events: (1) the release of pollutants (in this case from underground storage tanks); (2) the impact of these releases on ambient environmental quality; and (3) exposure of people, plants, animals, and materials through various media (air, water, etc.). The analyst should strive to consider the entire spectrum of impacts and attempt to quantify those impacts that can be assigned a dollar value as well as those which can only be described qualitatively. The EPA Guidelines also recommends that in addition to most likely estimates, upper and lower confidence limits be presented.

The next section discusses the methodology used to estimate benefits. Considerable attention in the methodology section is focused on the tricky problem of dealing with corrective action costs in benefit/cost analysis for this rule. A rationale is provided for casting the basic trade-off costs of prevention and detection versus corrective action costs avoided and residual damages. Subsequent sections of this chapter examine health and safety benefits (7.C), avoided property damages and foregone profits (7.D), environmental effects defined broadly (7.E) and option and existence values (7.F).

7.B. METHODOLOGY

Although the chapter focuses on the costs of UST releases, the analysis is termed "benefits analysis" for the following reason: each regulatory option, as discussed in Chapter 5, results in significant reductions in aggregate plume acreage in comparison to the base-case scenario. Provided social costs (i.e., damages) positively correlate with plume acreage, each option avoids costs (in comparison to the base case) and thus conveys benefits. These incremental benefits are calculated as follows:

$$PVBi = PVDb - PVDi \quad (1)$$

where PVBi = present value of benefits for option "i"

PVDb = present value of social costs for the base case

PVDi = present value of social costs for option "i"

Of particular concern in the benefits analysis is the treatment of corrective action costs. There are two ways in which corrective action costs can be represented in benefit/cost analysis. First, corrective action costs can be viewed as a program compliance cost and entered on the cost side of the ledger. Alternatively, corrective action costs can be viewed as a component of the social costs associated with UST releases. When corrective action costs are added to damages, they are considered in the benefits analysis as social costs avoided.

Is one approach preferred over the other? Assuming that corrective action costs and environmental damages are calculated so that there is no double counting (discussed below), both approaches yield the same relative rankings of the alternatives. However, the magnitude of incremental benefits will be lower if corrective action costs are included as a cost term.

There is another argument that can be made for incorporating corrective action costs into the benefits analysis. The magnitude of corrective action costs is both a function of other actions taken under the UST rule (new tank standards, monitoring and detection requirements) and a policy variable. As more stringent prevention and detection measures are required, the number and size of releases decreases and, other things being equal, aggregate corrective action costs will also decrease. However, for a given set of preventive measures, corrective action costs will vary as the level of cleanup required by the regulatory agency varies; more stringent cleanup standards imply greater corrective action costs.

Thus, as pointed out in Chapter 2, there is an interrelationship between prevention and detection policies on the one hand, and corrective action policies on the other hand. Improved prevention and detection reduces contamination incidents and therefore reduces corrective action costs. Therefore, in order to analyze prevention and detection policies against each other, it is necessary to hold corrective action policy constant. Similarly, in order to analyze alternative corrective action policies, it is necessary to hold prevention and detection policy constant. In this analysis, corrective action policy is held constant across all regulatory options, thus facilitating the comparison of prevention and detection options. In order to choose the most cost-effective policy for prevention and detection, it is necessary that the base case also include the same corrective action policy as the regulatory options. To do otherwise would distort the capability of the analysis to present meaningful data for evaluating trade-offs. The rationale for using the corrective action policy chosen is presented in the Preamble to the proposed rule. Thus, one way to view this issue is that the costs of increased prevention and detection are traded off against the reduced costs of corrective action. Also included on the benefits side of the ledger are the residual damages which are not remedied by corrective action (i.e., damages which occur before the corrective action is initiated).

As mentioned earlier, there is some concern about double counting corrective action costs and damages. In benefit/cost analysis, the measure of benefits should reflect social values and not private values, unless they are the same. Once a release occurs, the social objective should be to select that level of corrective action which theoretically minimizes the sum of damages and corrective action costs. Thus, corrective action is taken if the benefits (future health, property and environmental damages avoided) exceed the costs of the corrective action. Unfortunately, this theoretical trade-off is quite difficult to make in the real world.

In practice, corrective action decisions do not always reflect consideration of these trade-offs. Corrective actions which sometimes appear excessive may be explained by several factors, such as local or state requirements that releases be cleaned up to background levels, policies that polluters should clean up releases regardless of damages, uncertainty about the effectiveness of corrective action, or imperfect information on the potential for future damages. In the latter case, if there is a small probability of significant damages, the local or state agency is likely to err on the side of more rather than less corrective action.

In some cases, however, too little corrective action may be taken because owners lack financial assets to pay for corrective action or local or state agencies lack the resources to effectively coordinate corrective actions at all sites. On net, it will be assumed that the sum of corrective action costs and monetized damages does not involve significant double counting.

Corrective action costs have already been discussed and estimated in Chapter 5. The remainder of this chapter is devoted to the description of four broad categories of damages associated with UST releases:

- Section 7.C discusses health and safety risks;
- Section 7.D discusses property damages and foregone profits;
- Section 7.E discusses environmental effects; and
- Section 7.F discusses option and existence value.

For only one category, property damages and reduced firm profits, are aggregate damages expressed in monetary terms. For health and safety effects, aggregate incidents are estimated but not monetized. The analysis in Section 7.E suggests that there is significant potential for environmental effects but these effects are very difficult to quantify. The final category, reductions in option and existence values, can be described but quantification would involve substantially more analysis. It is assumed that society's willingness to clean up releases, even when there is no obvious justification in terms of quantifiable damages avoided, is partly a reflection of our desire to protect intrinsic values, such as option and existence value.

7.C. HEALTH AND SAFETY RISKS

Protecting human health is one of the primary goals of RCRA in general and of the UST regulations in particular. Releases from USTs threaten human health in two ways: (1) they represent a safety hazard due to the potential for fire and explosion, and (2) exposure to contaminants in water supplies or the atmosphere poses risks of chronic health effects. For the benefits analysis, we have focused on chronic health effects rather than the safety hazard. Although the safety issue is not a trivial one (the release incident survey documented 141 fire and explosion incidents out of a total of 10,000 release incidents[1/]), it appears that there is a serious threat only in certain circumstances, (e.g., where floating plumes seep into basements excavated below the water table). Subsequent analysis may need to explore safety risks in more detail.

7.C.1. Approach and Assumptions

We analyzed human health risks from leaking USTs using many of the same outputs from the UST model that support other parts of this RIA. Our approach is explained in detail in Appendix F; a very brief summary follows.

Our analysis estimates the incremental cancer risks resulting from exposure to the benzene component of gasoline released from a population of USTs. Our methodology is intended to provide a logical basis for determining the extent of risk in the base case and under the regulatory options. Although we believe the methodology provides a solid analytical framework, we caution that our results should be regarded as preliminary, and invite comments on how to improve the approach and underlying data base.

We limited the scope of our analysis to risks from ingesting ground water contaminated by gasoline released by USTs. We used the leak rates, floating plume sizes, and leak durations output by the UST model, and the same assumptions used elsewhere in this RIA regarding the proportion of existing tanks that are bare steel and fiberglass. We simulated risks under two sets of assumptions: in the first, exposure stops as soon as either the leak is detected or the pollutant concentrations in ground water exceed the taste threshold; in the second, leak detection stops exposure, but concentrations above the taste threshold do not. Based on a screening analysis, we assumed that most of the health risk posed by gasoline-contaminated water is associated with the benzene fraction of gasoline, and thus limited our analysis to risks from benzene exposures. We modeled concentrations of benzene in ground water over a thirty-year period, estimated lifetime exposures, and used EPA's estimate of the carcinogenic potency of benzene to predict the upper-bound cancer risk for different exposure scenarios.

We developed 9,720 different exposure scenarios for each regulatory option. These comprise combinations of three tank designs (existing bare steel, existing fiberglass, and replacement tank design), four vadose (unsaturated) zone types, nine floating plume sizes, three ground-water velocities, and 30 exposure wells. Each of these factors has an effect on estimated risk:

- Tank design affects the frequency with which leaks develop, and the leak rate once the tank has failed.

- Vadose zone type influences the dimensions of the floating gasoline plume for a given leak.

1/ EPA, Office of Solid Waste, Analysis of the National Data Base of UST Release Incidents, January 31, 1986

- o Floating plume size affects the transfer of benzene from the floating plume to the aqueous (ground-water) phase and the degree to which the contaminant is concentrated along the center line of the dispersed plume.

- o Ground-water velocity affects the transit time for benzene to reach the wells and its concentration in the water reaching the wells. All of the aquifers modeled are water table (unconfined) aquifers; confined aquifers would have lower concentrations of benzene.

- o Well locations relate to the intensity and duration of exposure to benzene in the drinking water.

The replacement tank design and leak detection methods vary among each of the regulatory scenarios, in turn affecting the frequency of failure and leak rates. We combined all of the information elements above for the base case and each of the regulatory scenarios to predict cancer risk for individuals drinking from wells. In addition, we estimated the number of people potentially exposed at each well, and were thus able to estimate population risk (i.e., the total number of statistically expected cases of cancer across the entire potentially exposed population).

Finally, we estimated or simulated frequency distributions for each of the factors that, when combined, define the scenarios. Tank design and population at exposure wells are independent distributions. We estimated a joint frequency distribution for tanks within each of the twelve vadose zone and ground-water velocity combinations, and simulated the joint distribution for tank design/vadose zone/floating plume size. We calculated an estimated frequency for each exposure scenario, and used these to generate a weighted distribution of individual risk for each regulatory option.

7.C.2. Results

Exhibit 7.1 shows the frequency of tanks in different risk intervals for the base case and the regulatory options under the assumption that exposure does not stop when pollutant concentrations exceed the taste threshold. Our key findings are:

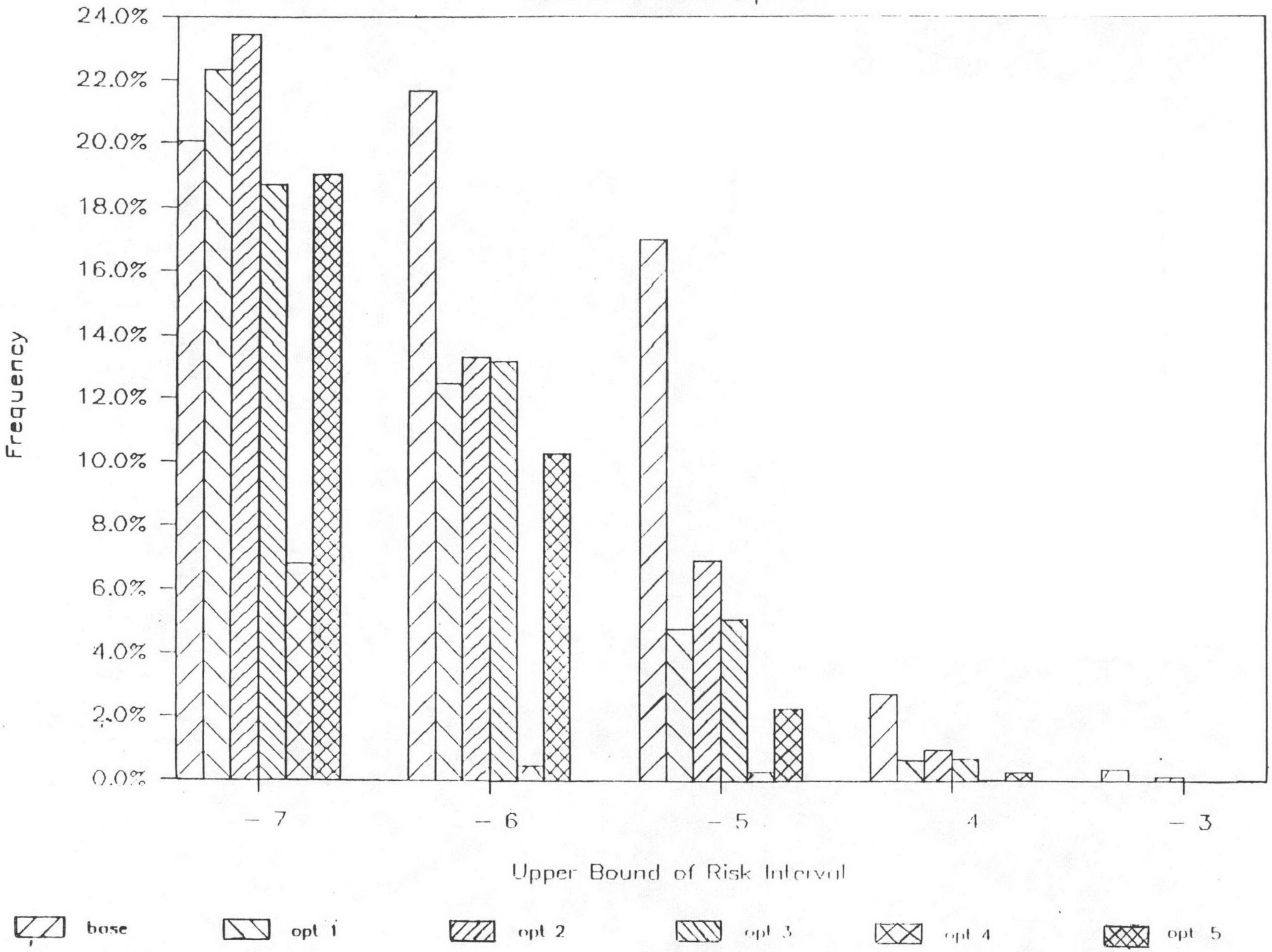
- o If exposure stops immediately after detection of a leak, but is not limited by the taste threshold, base case risks range as high as one in 1,000. About 20% of the tanks have risks greater than 10^{-6}. EPA often uses a lifetime cancer risk of one in a million (10^{-6}) as a threshold for regulatory concern.

- o If exposure ends immediately upon detection of a leak or when concentrations exceed the taste threshold for benzene, upper-bound lifetime cancer risks from drinking ground water downgradient of leaking USTs range from about one in 100,000 down to zero in the base case. About seven (7) percent of tanks have risks to the most exposed individual (MEI) greater than 10^{-6}.

Exh : 7.1

Frequency of MEI Risk

Base Case vs. all Options



- Of the environmental factors we evaluated (vadose zone type, groundwater velocity, well distance, and time of travel [TOT] from the tank to the well), TOT has the greatest influence on risk. All of the scenarios where predicted risks exceed 10^{-6} have TOTs of three years or less.

- All of the regulatory options reduce risks. When we assume that taste does limit exposure, about 7% of tanks have risks exceeding 10^{-6} in the base case, and the percentage is reduced to 1.6% by Option I, 2.9% by Option II, 1.7% by Option III, zero by Option IV, and 1.9% by Option V. When taste does not limit exposure, in the base case 20% of tanks have risks greater than 10^{-6}. The percentage is reduced to 5% in Option I, 8% in Option II, 6% in Option III, 0.3% in Option IV, and 3% in Option V.

- Option IV is the most effective, and virtually eliminates risks above 10^{-6}. The reason this option performs so well is that in our simulation we applied the most stringent regulatory requirements to exposure scenarios with the shortest TOT from tank to well. All of the high risk scenarios have short TOTs.

- There is little difference in performance between Options I, II, III, and V (see Exhibits 7.1 and 7.2).

7.D. Property Damage Benefits

7.D.1. Property Damages Avoided as a Benefits Measure

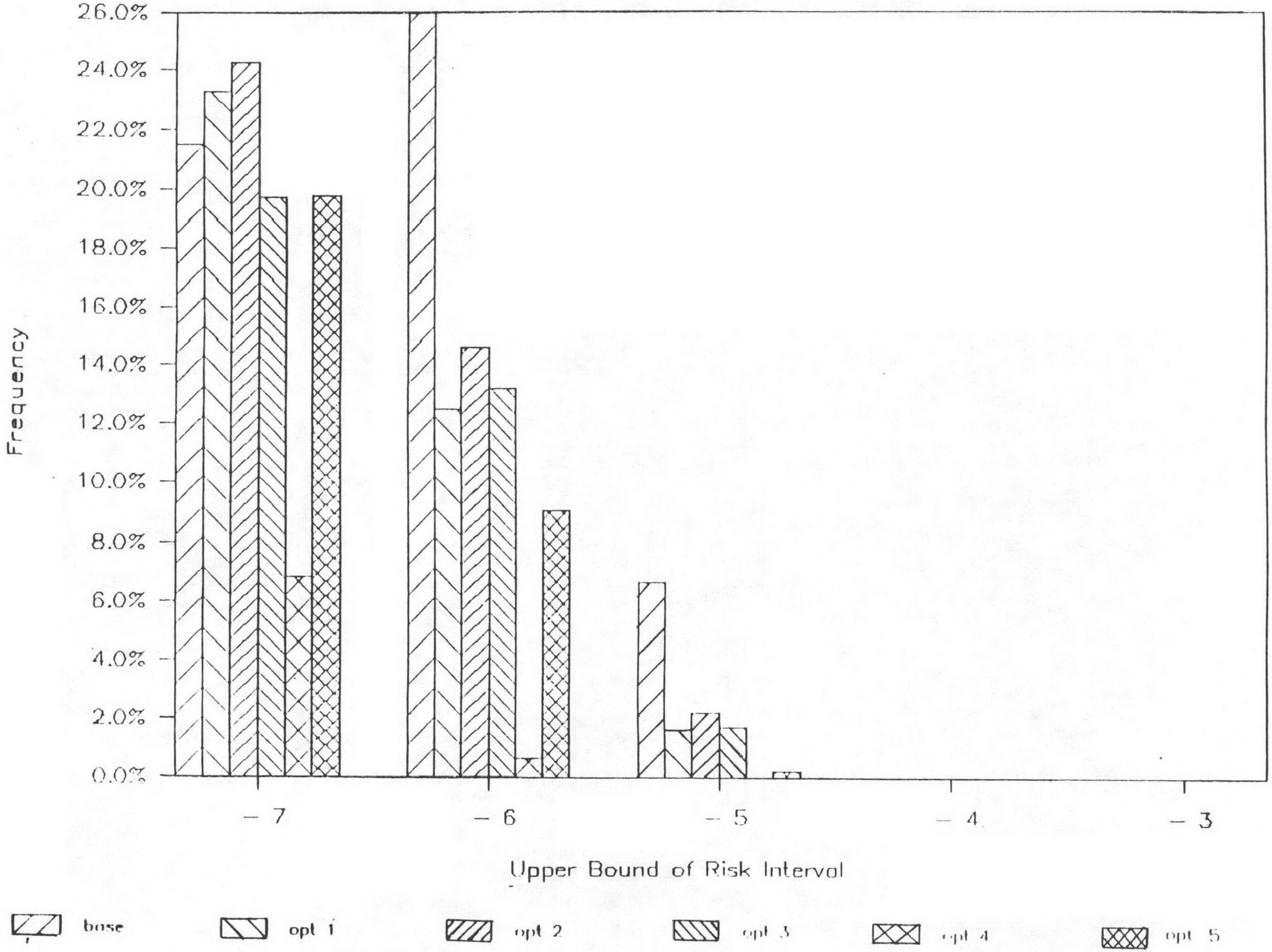
Damages to property constitute a major detrimental effect of UST leaks. To the extent that regulatory options reduce the number and severity of UST leaks, property damages are avoided. These desirable outcomes are consequently benefits of the regulatory options.

For convenience, three types of "property" are considered in the context of UST leaks: on-site, off-site business, and residential. On-site damages are those that would theoretically be reflected in the value of the tank owner's property. Off-site business damages would theoretically affect the value of an affected business property. Residential damages are also off-site, and affect residential property values. It is worth noting that if a leak damages residential rental property, it is best thought of as an off-site business damage, at least in the long-run. In the short-run, the renter may incur certain costs. In the long-run though, competitive pressures should shift the burden of these costs to the property owner in the form of reduced property values. There may be other artifacts of the classification scheme selected for this analysis, but it should serve its purpose well.

Property damages caused by an UST leak typically occur when a contaminated groundwater plume contacts a well or structural foundation (usually a basement or sump system). Contact with a well effectively renders the well water unsuitable for most uses. Contact with a foundation may result in unpleasant or dangerous vapors in a home or other building.

Exh 7.2

Frequency of MEI Risk (with T/O Cutoff)
Base Case vs. all Options



One alternative for measuring the benefits of avoiding damages of this type is to use the replacement cost method. The replacement cost method determines the value of benefits by examining the avoided costs of having to replace the services once provided by a damaged resource. In the present context, a well constitutes a private resource owned by a business or household. The well provides water for drinking, bathing, washing, cooking, etc. A building provides shelter for households or businesses.

Well and building services can be quickly and severely interrupted by a contaminated ground-water plume. Fortunately, these services can usually be replaced. However, replacement can be costly. By estimating the costs of replacing the services of affected wells and buildings, we can estimate the benefits of avoiding well and vapor damages of the type caused by UST leaks.

The replacement cost method is an imperfect technique for valuing benefits of avoiding well and vapor contamination. It may be unable to estimate certain of the costs imposed by damages. Consider the case of a contaminated well on the property of a homeowner. "Replacing" the well services may involve the purchase of bottled water for a short period of time, followed by connection of the home to a municipal water supply. Estimating the costs of these two items may seem straightforward. However, it is difficult to estimate the inconvenience cost of having to identify the solution and implement it. In the short-run, the household may incur the cost associated with having to use less water. Once connected to a municipal line, the quality of that water may be higher or lower than the quality of the water from the well before it was connected. Consequently, replacement cost estimates should be interpreted with caution. We cannot even say with certainty that benefits so estimated will be systematically under- or over-stated.

7.D.2. Underlying Assumptions and Requirements in the Aggregation Process

This benefits analysis involves combining replacement cost estimates with a damage function that relates UST leaks to well and vapor damages. The point of departure in the damage function approach is an estimate of the number and size of contamination plumes that would occur in the base case and under each of five regulatory options. An output of the EPA UST model, these estimates are provided for five-year increments during a thirty year period. There are nine plume size categories. Plume sizes range from 1 square meter to 10,000 square meters.

Exhibit 7.3 reports the set of plume size coefficients used in this analysis. The estimates are on a per-tank basis for the entire thirty-year period. For example, Exhibit 7.3 indicates that, in the base case, there would be 0.18 1000-square-meter plumes per tank over the entire thirty-year period. We do not know how these 1000-square-meter plumes would be distributed over time. We do have estimates, however, of how all plumes would be distributed over time. These coefficients are reported in Exhibit 7.4. Exhibit 7.4 shows, for example, that in the base case there would be 0.45 plumes per tank during the first five years, 0.25 plumes per tank during the second five years, etc.

Exhibit 7.3

Coefficients of Plume Size

Plume size	1	10	25	100	500	1000	2000	5000	10000
Base case	0.1	0.17	0.12	0.29	0.39	0.18	0.14	0.02	0.01
Option 1	0.23	0.28	0.24	0.24	0.24	0.09	0.03	0.01	0
Option 2	0.21	0.21	0.16	0.18	0.14	0.06	0.03	0.01	0
Option 3	0.19	0.26	0.24	0.21	0.23	0.09	0.03	0.01	0
Option 4	0.18	0.23	0.16	0.16	0.16	0.06	0.02	0	0
Option 5	0.01	0.19	0.09	0.08	0.08	0.03	0.01	0	0

Exhibit 7.4

Number of Plumes Per Tank

	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
Base case	0.45	0.25	0.20	0.19	0.17	0.16
Option 1	0.40	0.15	0.10	0.30	0.21	0.20
Option 2	0.45	0.25	0.20	0.05	0.03	0.02
Option 3	0.45	0.20	0.20	0.17	0.13	0.11
Option 4	0.40	0.15	0.15	0.12	0.10	0.05
Option 5	0.40	0.09	0.00	0.00	0.00	0.00

Examination of Exhibit 7.3 reveals that the different options have different effects on the size of plumes over time. Under Option II, the percentage of leaks that are of the three smallest sizes, 1, 10, and 25 square meters, increases. At the same time, the percentage of larger leaks falls substantially.

Since the coefficients in Exhibits 7.3 and 7.4 are on a per-tank basis, the absolute number of plumes can be estimated by multiplying the coefficients by the number of tanks that are expected to be in service during the thirty-year period: 1.4 million. Exhibits 7.5 and 7.6 report these results. Exhibit 7.5 indicates, for example, that under Option II there would be a total of 224,000 25-square-meter plumes over thirty years. Exhibit 7.6 reports that under Option II, there would be 280,000 plumes of all sizes during years 11 through 15.

Estimates of the numbers of plumes of different sizes that would occur during each five-year increment can be estimated by assuming that the distribution of all plumes over time would hold for individual plume sizes. Exhibits 7.7 through 7.12 report these results. Consider the results in Exhibit 7.7, which show projected plumes of different sizes over time in the base case. This table shows that there would be 79,859 plumes sized 1,000 square meters during years 1-5, 44,366 plumes of this size during years 6-10, etc. In total, there would be 252,000 such plumes over the thirty-year period in the base case. Note that this is the number of 1,000-square-meter plumes projected in the base case in Exhibit 7.5.

The assumption that the distribution over time would be constant for all plume sizes is questionable. It seems likely that, at least under some options, there would be a tendency for large plumes that do occur to occur sooner, due to detection requirements. Consequently, the benefits estimates that are derive from this assumption may be biased.

Plume shape is another component of the damage function. Due to groundwater flow, plumes tend to be irregular in shape -- perhaps elliptical or triangular -- rather than round. While plumes are probably not typically normal ellipses or triangles, we have, for convenience, assumed that they are. This makes it relatively simple to compute the distance from the tank to the leading edge of the plume.

Exhibit 7.13 shows the nine plume size categories measured three ways: square meters (the way the data are provided), distance in feet from tank to leading edge, and acres. It is worth noting that as plume area increases, distance from tank to the leading edge of the plume increases far less than proportionally. For example, a 2,000-square-meter plume is twice as large as a 1,000-square-meter plume. However, the distance from the tank to the leading edge of the plume is only 1.4 times greater for the larger plume.

The choice of a triangular versus elliptical proxy for plume shape is important in that the two different shapes yield very different areas per plume. For instance, take the example of well contamination. Exhibit 7.13A shows the farthest distance given from tank to a well for the well cases in our case studies. As is clear from the table, the elliptical proxy yields an area more than three times as large as the triangular one does. If the real-world situation is that most plumes are triangular, then the elliptical model is an inaccurate one, and vice versa.

Exhibit 7.5

Number of Plumes by Size, Thirty-Year Time Period

Plume size	1	10	25	100	500	1000	2000	5000	10000	Total
Base case	140,000	238,000	168,000	406,000	546,000	252,000	196,000	28,000	14,000	1,988,000
Option 1	322,000	392,000	336,000	336,000	336,000	126,000	42,000	14,000	0	1,904,000
Option 2	294,000	294,000	224,000	252,000	196,000	84,000	42,000	14,000	0	1,400,000
Option 3	266,000	364,000	336,000	294,000	322,000	126,000	42,000	14,000	0	1,764,000
Option 4	252,000	322,000	224,000	224,000	224,000	84,000	28,000	0	0	1,358,000
Option 5	14,000	266,000	126,000	112,000	112,000	42,000	14,000	0	0	686,000

Exhibit 7.6

Total Number of Plumes, by Five-Year Increments

	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years	Total
Base case	630,000	350,000	280,000	266,000	238,000	224,000	1,988,000
Option 1	560,000	210,000	140,000	420,000	294,000	280,000	1,904,000
Option 2	630,000	350,000	280,000	70,000	42,000	28,000	1,400,000
Option 3	630,000	280,000	280,000	238,000	182,000	154,000	1,764,000
Option 4	560,000	210,000	210,000	168,000	140,000	70,000	1,358,000
Option 5	560,000	126,000	0	0	0	0	686,000

Exhibit 7.7

Number of Plumes, by Size -- Base Case

Plume size	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
1	44,366	24,648	19,718	18,732	16,761	15,775
10	75,423	41,901	33,521	31,845	28,493	26,817
25	53,239	29,577	23,662	22,479	20,113	18,930
100	128,662	71,479	57,183	54,324	48,606	45,746
500	173,028	96,127	76,901	73,056	65,366	61,521
1,000	79,859	44,366	35,493	33,718	30,169	28,394
2,000	62,113	34,507	27,606	26,225	23,465	22,085
5,000	8,873	4,930	3,944	3,746	3,352	3,155
10,000	4,437	2,465	1,972	1,873	1,676	1,577
TOTAL	630,000	350,000	280,000	266,000	238,000	224,000

Exhibit 7.8

Number of Plumes, by Size -- Option 1

Plume size	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
1	94,706	35,515	23,676	71,029	49,721	47,353
10	115,294	43,235	28,824	86,471	60,529	57,647
25	98,824	37,059	24,706	74,118	51,882	49,412
100	98,824	37,059	24,706	74,118	51,882	49,412
500	98,824	37,059	24,706	74,118	51,882	49,412
1,000	37,059	13,897	9,265	27,794	19,456	18,529
2,000	12,353	4,632	3,088	9,265	6,485	6,176
5,000	4,118	1,544	1,029	3,088	2,162	2,059
10,000	0	0	0	0	0	0
TOTAL	560,000	210,000	140,000	420,000	294,000	280,000

Exhibit 7.9

Number of Plumes, by Size -- Option II

Plume size	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
1	132,300	73,500	58,800	14,700	8,820	5,880
10	132,300	73,500	58,800	14,700	8,820	5,880
25	100,800	56,000	44,800	11,200	6,720	4,480
100	113,400	63,000	50,400	12,600	7,560	5,040
500	88,200	49,000	39,200	9,800	5,880	3,920
1,000	37,800	21,000	16,800	4,200	2,520	1,680
2,000	18,900	10,500	8,400	2,100	1,260	840
5,000	6,300	3,500	2,800	700	420	280
10,000	0	0	0	0	0	0
TOTAL	630,000	350,000	280,000	70,000	42,000	28,000

Exhibit 7.10

Number of Plumes, by Size -- Option III

Plume size	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
1	95,000	42,222	42,222	35,889	27,444	23,222
10	130,000	57,778	57,778	49,111	37,556	31,778
25	120,000	53,333	53,333	45,333	34,667	29,333
100	105,000	46,667	46,667	39,667	30,333	25,667
500	115,000	51,111	51,111	43,444	33,222	28,111
1,000	45,000	20,000	20,000	17,000	13,000	11,000
2,000	15,000	6,667	6,667	5,667	4,333	3,667
5,000	5,000	2,222	2,222	1,889	1,444	1,222
10,000	0	0	0	0	0	0
TOTAL	630,000	280,000	280,000	238,000	182,000	154,000

Exhibit 7.11

Number of Plumes, by Size -- Option IV

Plume size	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
1	103,918	38,969	38,969	31,175	25,979	12,990
10	132,784	49,794	49,794	39,835	33,196	16,598
25	92,371	34,639	34,639	27,711	23,093	11,546
100	92,371	34,639	34,639	27,711	23,093	11,546
500	92,371	34,639	34,639	27,711	23,093	11,546
1,000	34,639	12,990	12,990	10,392	8,660	4,330
2,000	11,546	4,330	4,330	3,464	2,887	1,443
5,000	0	0	0	0	0	0
10,000	0	0	0	0	0	0
TOTAL	560,000	210,000	210,000	168,000	140,000	70,000

Exhibit 7.12

Number of Plumes, by Size -- Option V

Plume size	1-5 years	6-10 years	11-15 years	16-20 years	21-25 years	26-30 years
1	11,429	2,571	0	0	0	0
10	217,143	48,857	0	0	0	0
25	102,857	23,143	0	0	0	0
100	91,429	20,571	0	0	0	0
500	91,429	20,571	0	0	0	0
1,000	34,286	7,714	0	0	0	0
2,000	11,429	2,571	0	0	0	0
5,000	0	0	0	0	0	0
10,000	0	0	0	0	0	0
TOTAL	560,000	126,000	0	0	0	0

Exhibit 7.13

Plume Measurements

Plume size (sq. meters)	Distance from source (feet)	Plume size (acres)
1	3.88	0.0002
10	12.28	0.0025
25	19.40	0.0062
100	38.82	0.0247
500	86.80	0.1235
1000	122.76	0.2471
2000	173.60	0.4942
5000	274.48	1.2355
10000	388.18	2.4710

Fortunately, the shape of the plume is not the only way to determine a maximum number of contaminated wells and structures for each size plume. For well cases, the number of wells contaminated per size plume was derived in the following manner. Two approaches were used to develop the maxima. One approach was based on a geometric analysis of the possible numbers of wells in an area over a given size plume. Using a standard of one-quarter-acre plots of land per structure, it was determined that each 1000 square meters would contain at a maximum one structure. This holds for both triangular and elliptical shaped plumes. In the case of a 10,000-square-meter plume, a maximum of 10 structures could be accommodated. However, this would not allow any space for on-site land, roads, and other public areas, so it is unlikely that 10 units would exist in a 10,000-square-meter area. Some number less than ten would be more accurate.

The other method used to determine the number of affected wells was an analysis of empirical data available to us. These data indicate that the number of wells affected drops gradually as the plume size declines. The maximum number of wells found in a 10,000-square-meter site averaged about 5. Given this fact and the belief that there would have to be less than 10 wells in such an area, the number 5 was selected for the maximum number of wells in the 10,000-square-meter case.

For the smaller size cases, the number of wells affected generally dropped as the plume size decreased. We therefore chose to have the maximum drop gradually as well, declining from 5 wells to 3 wells for a 5,000-square-meter plume, to 2 for a 2,000-square-meter plume, to 2 for a 1,000-square-meter plume, and to 1 for all other plume sizes. Such a decrease also squares with the geometric analysis, which clearly indicates that the number of prospective well sites will drop as land area decreases.

In vapor cases, the geometric approach was found to be unrealistic, based on the real-world observations that were available. The data indicate that it is extremely rare for any given leak to contaminate more than one structure. Therefore we have set a limit of one structure per leak for vapor cases.

Another important assumption in the damage function process involves the proximity of plumes to one another. Exhibit 7.5 showed that, in the base case, there are projected to be 1,988,000 plumes over a thirty-year period. It is entirely possible that some of these plumes would intersect one another. Indeed, observation of actual UST leak incidents suggests this is very likely. For instance, in a Florida case where several wells were contaminated, there were three possible sources of contamination, that is from three leaking tanks, in the general vicinity. How many plumes would intersect and how plume sizes and shapes would be affected is unknown. In this analysis, it is assumed that each plume would be separate; there would not be any intersection of plumes. It is likely that this assumption introduces upward bias into the benefits estimates since it projects more damaged wells and buildings in the base case than might actually occur. This follows if it is assumed that a well damaged by "two" plumes is no more costly than a well damaged by a single plume. Turning to the Florida case once more, it did not matter to the affected residents whether one or ten leaking tanks were the source of their well contamination; all that mattered was the subsequent loss of water use and the steps that had to be taken to obtain a new source. This did not depend on the number of plumes.

Exhibit 7.13(A)

Compilation of Well Contamination and Distance

Number of Wells	Distance (m)	Elliptical Area (m**2)	Triangular Area (m**2)
1	3	6	1
1	6	26	6
1	11	86	20
1	12	103	23
1	15	160	36
1	15	160	36
1	15	160	36
1	15	160	36
1	18	231	53
1	21	314	72
2	23	377	86
1	24	411	93
1	30	642	146
1	30	642	146
1	30	642	146
2	30	642	146
2	30	642	146
2	30	642	146
2	42	1,258	286
1	45	1,444	328
1	45	1,444	328
2	45	1,444	328
3	46	1,509	343
3	61	2,654	603
1	76	4,119	937
2	76	4,119	937
3	92	6,036	1,373
2	114	9,268	2,107
1	152	16,476	3,747
1	152	16,476	3,747
1	182	23,622	5,371
1	183	23,882	5,431
1	200	28,526	6,486
1	213	32,355	7,357
2	274	53,540	12,174
7	274	53,540	12,174
6	396	111,832	25,430
4	403	115,821	26,337

(a) The ellipse is assumed to have an area A=pi(0.227)x^2, where x is the distance between the furthest ends of the ellipse.
(b) The triangle is assumed to have an area A=(6/37)x^2, where x is the distance between the base and the height of the triangle.

Finally, many of the replacement costs would be incurred in the future. Thus, the benefits of avoiding such costs should be expressed in present value terms to allow comparison with regulatory costs. Two discount rates are employed in this analysis: 3 and 10 percent.

The only explicitly on-site benefits considered in this section are avoided profit losses that tank owners incur following leaks. We assume that each plume is from a different site (primarily gasoline retailer). Losses are measured as foregone profits -- the difference between gross revenues and operating costs. The estimated loss per establishment with a plume varies across the three scenarios as the assumed net-revenue loss per week and duration of loss varies. These estimates are derived from a small sub-set of the 141 case studies of known UST plumes which was used in this analysis.

7.D.3. Damage Function Estimation

Due to the high level of uncertainty involved in estimating the national benefits of the regulatory options, three different scenarios are considered. Under Scenario A, which might be thought of as a conservative estimate of benefits, variable values are selected that minimize damage estimates, and consequently benefits. Scenarios B and C are medium and high estimates, respectively.

The national benefits of avoiding vapor damages is expressed as a simple multiplicative function of four variables. These variables are:

- o the expected number of plumes;
- o the probability, per plume, that some sort of vapor damage will occur;
- o the expected number of affected structures per vapor incident;
- o the estimated replacement/restoration cost per structure.

The number of plumes of various sizes expected each year under each regulatory option have already been presented in Exhibits 7.7-7.12. These estimates do not vary across Scenarios A, B, and C.

The probability per plume of vapor damage occurring has been estimated using actual field data on UST leaks. Data from 141 known UST plumes have been analyzed. Probabilities of a damaging leak occurring were calculated for each plume size and for each kind of incident. To calculate the probabilities, the 10,000-square-meter plume was used to set a limit on the maximum probability of any size leak causing contamination. For example, let us examine the vapor case category. Of the 72 plumes for which distance data were available, 19 were at least 10,000 square meters in size. Of the 19, 5 were known to have caused vapor damages. Thus, approximately 26 percent (5/19) of these size cases had vapor impacts.

Given that 26 percent of the 10,000-square-meter plumes cause vapor damages, it is now possible to determine the probability for other size vapor cases. This was done using the following method. It is assumed that as a plume's size decreases, the probability that any damages occurring from that plume will decrease. Consequently, the probability for a given size plume is scaled down according to its size in relation to the 10,000-square-meter plume. For example, take the case of a 500-square-meter plume. This plume has a minimum distance (based on the elliptical model of plume shape) of 40 feet from the tank, while the 10,000-square-meter plume has a minimum distance of 275 feet. Dividing 40 into 275 yields that the distance for the 500-square-meter plume is 14.5 percent that of the 10,000-square-meter plume. Multiplying this 14.5 percent by the 26 percent probability of the large plume causing vapor damages indicates that there is about a 4 percent chance of the 500-square-meter plume causing any vapor damages. This method was applied to all the different size plumes for vapor and private well cases.

Another important consideration is that the 141 UST cases were from "known" plumes; i.e., plumes that have been detected by state authorities. It is universally agreed that many plumes go undetected altogether. Assume that if a plume does vapor damage, it gets reported and detected. This implies that none of the undetected plumes do vapor damage. Several state environmental authorities were asked to estimate the proportion of total UST leaks that go undetected. While many declined to estimate, several others did offer opinions. There was agreement that 50 to 70 percent of leaks go undetected; i.e., that 30 to 50 percent of leaks are detected. This implies, for instance, that far fewer than 26 percent of all 10,000-square-meter plumes do vapor damages.

To compensate for this fact, the probabilities of damages occurring from a given leak size were modified using an adjustment factor accounting for the probability of detection. This factor increases as plume size increases, since it is assumed that the rate of detection will increase as plume size increases. The 500-square-meter plume was chosen as a mid-point, where 50 percent of all leaks will be detected. The adjustment factor rises or decreases by 10 percent per plume size, to the point where, for example, any 10,000-square-meter plume will have an 80 percent probability of detection. The adjustment factor may then be multiplied by the probabilities derived previously to yield a much better proxy for the probability of a given leak's causing known damages. It should be remembered that these probabilities are based on a very small and biased dataset.

The expected number of affected structures per vapor incident has also been estimated from the field data. Of the 33 vapor cases, only two are known to have involved more than a single structure. They affected two structures in one case, and four structures in the other. As previously noted, we have assumed that a single structure is affected under all scenarios.

The final variable is the estimated damage cost per structure. The 141 field cases indicate a wide range of costs -- from $3,000 to $150,000. Some of the affected structures were business establishments, others were homes. The mean cost per structure was about $40,000, while the median cost was closer to $60,000. These estimates represent fewer than a dozen observations. Due to the uncertainty of these figures, the estimated cost per structure varies by scenario.

The benefits of avoiding private (residential or business) well contamination are considered separately from the benefits of avoiding public well contamination.

The national benefits of avoiding private well damages is expressed as a simple multiplicative function of four variables. These variables are:

- o the expected number of plumes;
- o the probability, per plume, that some sort of private well damage will occur;
- o the expected number of affected private wells per incident;
- o the estimated replacement/restoration cost per private well.

The number of plumes of various sizes expected each year under each regulatory option has already been presented in Exhibit 7.5. These estimates do not vary across scenarios.

The method used to derive the probability of a given size leak was the same as that used for vapor cases. The 10,000-square-meter plume had a 47 percent chance of causing damages, and this was used as a base, as 26 percent was used in the vapor cases. After the other probabilities were obtained, they were multiplied by the same detection adjustment factor used in the vapor cases, which was 50 percent of the 500-square-meter plumes, 1 percent of the 1-square-meter cases, and 80 percent of the 10,000-square-meter plumes being discovered.

The expected number of affected private wells per well incident has also been estimated from the field data. Of the 51 well cases, 20 are known to have involved more than a single well. Six cases involved five or more wells. The mean number of affected wells per well incident is three. As stated in Section 2, the maximum number of wells affected per well incident ranges from 5 wells for the 10,000-square-meter case to 1 for all cases 500 square meters or less.

The final variable is the estimated damage cost per private well contaminated. Based on the few case studies for which restoration/replacement costs were known, three estimates have been derived: $1,000, $3,000, and $10,000 under scenarios A, B, and C, respectively.

The probability of public well contamination is apparently lower than the probability of private well contamination, but the costs per incident are potentially much higher. Of the 141 UST leaks examined, 3 resulted in public well contamination. The data indicate a probability of about 4 percent that any 10,000-square-meter plume could contaminate a public well. However, this may be a high estimate, since the data that was collected was heavily biased in favor of leaks that cause substantial damage. Therefore, the probability for the 10,000-square-meter plume has been reduced to 1 percent to reduce the bias. The probability drops for the lower plume sizes by 0.25 percent for each consecutive size above the 500-square-meter plume. At this point, the probability is zero percent and remains at this level for the smaller sizes. It is assumed under all scenarios that a single public well is contaminated when such an incident occurs. The cost per public well affected does vary by scenario -- from $10,000 under Scenario A to $100,000 under Scenario C.

The only explicitly on-site benefits considered in this section are avoided profit losses that tank owners incur following leaks. We assume that each plume is from a different site (primarily gasoline retailer). Losses are measured as foregone profits -- the difference between gross revenues and operating costs. The estimated loss per establishment with a plume varies across the three scenarios as the assumed net-revenue loss per week and duration of loss varies. These estimates are derived from a small sub-set of the 141 case studies.

7.D.4. Property-Damages-Avoided Benefits Projections

Before turning to the model input data and intermediate results, the summary findings are reported. The data are presented in several forms to show the differences between the options. In addition, each table contains aggregate data by scenario for better comparison.

Exhibit 7.14 summarizes the benefits of the five control options relative to the base case at two discount rates -- 3 and 10 percent. The numbers in Exhibit 7.14 are the sum of the lost profits and benefits and are taken from Exhibits 7.15A and 7.17, respectively. Therefore, each entry in Exhibit 7.14 represents benefits from avoided vapor damages, private well damages, public well damages, and lost profits. For Option II under Scenario B (present value at 3 percent), 69 percent of the benefits are avoided lost profits, while avoided vapor damages, private well damages, and public well damages represent 24 percent, 6 percent, and 1 percent, respectively.

Exhibit 7.15 presents the lost profits of tank owners discounted at 3 and 10 percent. The lost profits result from the time a station experiencing a leak closes down. It is important to note that currently no damage probabilities are included (i.e., it is assumed that a leak always causes a closure of some length of time).

At a discount rate of 3 percent, damages are lower under Option II than under Option I. However, at a 10 percent discount rate, damages are slightly higher under Option II than under Option I. This can be explained with the aid of Exhibit 7.6. Note in Exhibit 7.6 that the aggregate number of detected plumes drops from 1.9 million under Option I to 1.4 million under Option II. This reduction comes solely during years 16-30. In fact, there are more plumes detected in years 1-15 under Option II. Consequently, present value damages under Option II are lower at low discount rates but higher at high discount rates.

The contamination from UST plumes must be examined by local authorities first-hand. In most cases, this requires the visual inspection of the tanks and surrounding ground areas. The digging necessary to remove the tanks causes many commercial facilities to shut down for a period of time. Examination of the available files has yielded the following data about the impacts on businesses that sell gasoline. The closing time for a station can vary widely. In some instances the station may close for only a week while the tanks are dug up; in other cases, the station may close for a period of months, years, or permanently. It appears from available data that most stations will shut down for a period of between 1 and 10 weeks.

Exhibit 7.14

Benefits Summary: Benefits of Control Options Relative to Base Case (Billions of Dollars)

Option	Scenario A	Scenario B	Scenario C
Present Value at 3 Percent			
I	0.3	2.0	5.7
II	0.6	3.4	9.0
III	0.3	2.0	5.7
IV	0.7	4.3	11.1
V	1.3	7.7	18.8
Present Value at 10 Percent			
	Scenario A	Scenario B	Scenario C
I	0.3	1.5	4.2
II	0.2	1.1	3.2
III	0.1	0.9	2.8
IV	0.3	2.1	5.5
V	0.6	3.3	8.3

Note: The figures in this table are the sum of the lost profits and benefits from Exhibits 7.15(A) and 7.17 respectively.

Net costs for the stations were available from the case files. The net cost for lost business during closure varied from $1,400 to $1,736 per week, with a mean of $1,568.

Given the number of plumes under each regulatory option for thirty years after implementation, lost profits of tank owners can be calculated. These plume numbers were derived earlier in this section. Three possible scenarios were examined: Scenarios A, B, and C. Under Scenario A, it was assumed that cost of closure to tank owners was $1,400 per week, and that the station was closed for one week. For Scenario B, it was assumed that cost of closure was $1,568 per week, and that the facility was shut down for a period of five weeks. Finally, under Scenario C, the assumption was that the tank owner had a cost of $1,736 per week, and that the facility closed for a period of ten weeks.

All of the cost figures were derived by multiplying the number of plumes in a given time period by the cost and period of closure for the specific scenario. Costs were discounted to the present using discount factors of 3 and 10 percent. The resulting estimated lost profits are presented in Exhibit 7.15.

Exhibit 7.15A reports the benefits of avoiding lost profits under Options I through V relative to the base case. It is interesting to note that the benefits are greater under Option II than under Option I when the benefits are discounted at a rate of 3 percent. The opposite is true when the discount rate is 10 percent. This has already been explained in the discussion of Exhibit 7.15.

Exhibit 7.16 reports the present value of vapor and well damages under each option and each scenario, discounted at 3 and 10 percent. The vapor and well damages are also presented at a 0 percent discount rate, which is just the total undiscounted damages. Damage estimates increase substantially under Scenarios A, B, and C for several reasons: probabilities of damages increase and costs per damaged well or structure increase. Vapor and public well damage costs become very important (proportionally) under Scenarios B and C.

Damages are lower under Option II than under Option I at discount rates of 0 and 3 percent, but are higher discounting at 10 percent. This occurs for the same reason that was explained for lost profits during the discussion of Exhibit 7.15 -- Option II avoids plumes beyond year 15.

Exhibit 7.17 presents projected benefits of Options I through V relative to the base case. Exhibit 7.18 presents the input assumptions which distinguish Scenarios A, B, and C from each other.

Exhibit 7.15

Lost Profits of Tank Owners

Millions of Dollars Discounted at 3 Percent

Option	Scenario A	Scenario B	Scenario C
Baseline	1,987	11,129	24,643
I	1,810	10,135	22,442
II	1,567	8,775	19,430
III	1,804	10,104	22,373
IV	1,431	8,016	17,749
V	858	4,802	10,633

Millions of Dollars Discounted at 10 Percent

Option	Scenario A	Scenario B	Scenario C
Baseline	1,141	6,389	14,146
I	970	5,434	12,032
II	1,041	5,829	12,908
III	1,072	6,002	13,291
IV	890	4,985	11,038
V	677	3,793	8,399

Exhibit 7.15(A)

Comparison of Lost Profits Relative to Base Case

Millions of Dollars Discounted at 3 Percent

Option	Scenario A	Scenario B	Scenario C
I	177	994	2,201
II	420	2,354	5,213
III	183	1,025	2,270
IV	556	3,113	6,893
V	1,130	6,327	14,010

Millions of Dollars Discounted at 10 Percent

Option	Scenario A	Scenario B	Scenario C
I	170	955	2,114
II	100	559	1,239
III	69	386	855
IV	251	1,404	3,108
V	463	2,595	5,747

Exhibit 7.16

Aggregate Damages

PRESENT VALUE OF DAMAGES, R = 3% ($10^6)

Option	Scenario A	Scenario B	Scenario C
Base case	211.67	1,591.42	5,710.60
I	76.15	611.51	2,211.21
II	68.46	539.58	1,945.78
III	80.31	642.36	2,321.40
IV	48.88	402.85	1,460.18
V	29.20	240.30	871.00

PRESENT VALUE OF DAMAGES, R = 10% ($10^6)

Option	Scenario A	Scenario B	Scenario C
Base case	121.51	913.56	3,278.19
I	40.83	327.87	1,185.58
II	45.48	358.45	1,292.62
III	47.71	381.60	1,379 06
IV	30.40	250.53	908.07
V	23.07	189.82	688.02

PRESENT VALUE OF DAMAGES, R = 0% ($10^6)

Option	Scenario A	Scenario B	Scenario C
Base case	296.44	2,228.77	7,997.64
I	112.15	900.68	3,256.82
II	85.64	674.94	2,433.90
III	109.93	879.24	3,177.44
IV	64.92	535.07	1,939.42
V	32.70	269.14	975.52

Exhibit 7.17

Comparison of Benefits to Base Case

PRESENT VALUE OF BENEFITS RELATIVE TO BASE CASE
R = 3% ($10^6)

Option	Scenario A	Scenario B	Scenario C
I	135.52	979.91	3,499.38
II	143.20	1,051.84	3,764.82
III	131.35	949.06	3,389.20
IV	162.79	1,188.57	4,250.41
V	182.47	1,351.12	4,839.60

PRESENT VALUE OF BENEFITS RELATIVE TO BASE CASE
R = 10% ($10^6)

Option	Scenario A	Scenario B	Scenario C
I	80.68	585.69	2,092.61
II	76.03	555.11	1,985.57
III	73.80	531.96	1,899.13
IV	91.11	663.03	2,370.12
V	98.44	723.74	2,590.17

Exhibit 7.18

Input Variables

Scenario A - Input Variables

Plume size (sq. meters)	P(vapor damages)	Vapor damages per structure	No. of structures per plume	P(private well damages)	Damages per private well	No. of private wells per plume	P(public well damages)	Damages per public well	Expected value of damages ($/plume)
1	0.000	$3,000	1	0.000	$1,000	1	0.0000	$10,000	$0.00
10	0.000	3,000	1	0.001	1,000	1	0.0000	10,000	1.00
25	0.002	3,000	1	0.004	1,000	1	0.0000	10,000	10.00
100	0.006	3,000	1	0.009	1,000	1	0.0000	10,000	27.00
500	0.016	3,000	1	0.028	1,000	1	0.0000	10,000	76.00
1000	0.040	3,000	1	0.075	1,000	2	0.0025	10,000	295.00
2000	0.072	3,000	1	0.126	1,000	2	0.0050	10,000	518.00
5000	0.119	3,000	1	0.210	1,000	3	0.0075	10,000	1,062.00
10000	0.208	3,000	1	0.376	1,000	5	0.0100	10,000	2,604.00

Scenario B - Input Variables

Plume size (sq. meters)	P(vapor damages)	Vapor damages per structure	No. of structures per plume	P(private well damages)	Damages per private well	No. of private wells per plume	P(public well damages)	Damages per public well	Expected value of damages ($/plume)
1	0.000	$40,000	1	0.000	$3,000	1	0.0000	$50,000	$0.00
10	0.000	40,000	1	0.001	3,000	1	0.0000	50,000	3.00
25	0.002	40,000	1	0.004	3,000	1	0.0000	50,000	92.00
100	0.006	40,000	1	0.009	3,000	1	0.0000	50,000	267.00
500	0.016	40,000	1	0.028	3,000	1	0.0000	50,000	724.00
1000	0.040	40,000	1	0.075	3,000	2	0.0025	50,000	2,175.00
2000	0.072	40,000	1	0.126	3,000	2	0.0050	50,000	3,886.00
5000	0.119	40,000	1	0.210	3,000	3	0.0075	50,000	7,025.00
10000	0.208	40,000	1	0.376	3,000	5	0.0100	50,000	14,460.00

Scenario C - Input Variables

Plume size (sq. meters)	P(vapor damages)	Vapor damages per structure	No. of structures per plume	P(private well damages)	Damages per private well	No. of private wells per plume	P(public well damages)	Damages per public well	Expected value of damages ($/plume)
1	0.000	$150,000	1	0.000	$10,000	1	0.0000	$100,000	$0.00
10	0.000	150,000	1	0.001	10,000	1	0.0000	100,000	10.00
25	0.002	150,000	1	0.004	10,000	1	0.0000	100,000	340.00
100	0.006	150,000	1	0.009	10,000	1	0.0000	100,000	990.00
500	0.016	150,000	1	0.028	10,000	1	0.0000	100,000	2,680.00
1000	0.040	150,000	1	0.075	10,000	2	0.0025	100,000	7,750.00
2000	0.072	150,000	1	0.126	10,000	2	0.0050	100,000	13,820.00
5000	0.119	150,000	1	0.210	10,000	3	0.0075	100,000	24,900.00
10000	0.208	150,000	1	0.376	10,000	5	0.0100	100,000	51,000.00

7.E. ENVIRONMENTAL EFFECTS

UST leaks have environmental effects, and thus reducing leaks has a benefit in terms of environmental effects avoided. The primary environmental effect is on aquatic ecosystems, and occurs when the release is transported on or in ground water and discharges to surface water. We performed a screening-level analysis on the aquatic impacts of gasoline releases from USTs in the base case to provide an indication of how often UST releases have the potential to pollute streams. As with the risk assessment discussed in Section 7.C, this analysis represents a first cut at estimating potential impacts from leaking USTs; we intend to develop a more complete methodology for subsequent analyses and invite comments on how to improve the underlying data and modeling approach.

As described below, we used some of the same UST model outputs as in other parts of the benefits analysis, i.e., the predicted rate of occurrence of leaks and the leak rates. However, there are several fundamentally different (and more conservative) assumptions employed in this analysis:

- All gasoline present in the floating plume travels to the nearest stream and discharges into the stream. This mass of gasoline is slightly less than the total leak volume as some gasoline is retained in the unsaturated zone. However, in most cases it is much more than the mass available for human exposure via ground water, (i.e., the mass of gasoline that disperses into the ground water).

- The floating plume reaches the nearest stream regardless of whether or not the leak is detected.

Other key assumptions, and our basic analytic framework, are summarized below.

7.E.1. Approach and Assumptions

Our approach has three components. First, we devised a set of exposure scenarios. Each scenario comprises a different combination of stream size (with a corresponding flow) and gasoline discharge rate, yielding a predicted gasoline concentration in the water column. Second, we attempted to determine the concentration of gasoline that is toxic to aquatic organisms. Third, we estimated the frequency with which each of the exposure scenarios occurs.

We used the hydrologic concept of stream order to provide the basis for the environmental settings for our exposure scenarios. Streams can be classified into orders, whereby a first order stream has no tributary channels, a second order stream is formed when two first order streams merge, a third order stream is formed when two second order streams merge, and so on. The highest stream order in the U.S. is tenth order, and is represented by the Mississippi River. Each stream order has characteristic properties, including mean flow and length[1/]. Exhibit 7.19 lists the stream characteristics used to develop our exposure scenarios.

[1/] Keup, L.E., "Flowing Water Resources", Water Resources Bulletin, Vol. 21, No. 2, April 1985, Pp. 291 - 296.

Exhibit 7.19

Summary of Data on U.S. Streams by Stream Order

Stream Order	Number of Streams	Total Length (miles)	Calculated Discharge(ft3/sec)
1	1,570,000	1,570,000	0.6
2	350,000	810,000	3.7
3	80,000	420,000	15.6
4	18,000	220,000	73
5	4,200	116,000	380
6	950	61,000	1,800
7	200	30,000	8,500
8	41	14,000	38,000
9	8	6,200	211,000
10	1	1,800	900,000

Source: Lowell E. Keup, "Flowing Water Resources", Water Resources Bulletin, Vol. 21, No.2, April 1985.

We used a simple dilution model to predict concentrations. The mass loading rate was derived using the UST model's outputs on floating plume size and duration. We assumed that all gasoline in the floating plume discharges to the nearest stream. The mass loading rate divided by flow yields the concentration in the stream. As mentioned earlier, our concentration estimates are conservatively high because we assume that the entire plume enters the stream. We did not account for dilution, degradation, and other fate and transport processes that may affect concentration. Another limitation of our approach is that we do not consider the effect of time on plume travel, or the probability of plumes in lower order streams merging with plumes in higher order streams.

Once concentrations were derived, the next step was to determine whether they exceeded a chronic toxicity threshold. The EPA has not established an Ambient Water Quality Criterion for gasoline or any of the specific hydrocarbons constituting gasoline. Therefore, we had to derive a concentration threshold that represents the level above which toxic effects may occur.

We were able to obtain only two sets of aquatic toxicity test results for gasoline, one using rainbow trout and the other using shad. Both tests were acute tests; we wanted to derive an estimate for the concentration that would cause chronic effects. We used three different extrapolation methods to estimate a maximum acceptable toxicant concentration (MATC) for chronic exposure, based on the two acute tests. In addition, we 'back-calculated' the chronic MATC for gasoline based on available toxicity data for benzene, toluene, xylene, and naphthalene. The MATCs derived by the four methods were surprisingly similar, ranging from 0.7 mg/l to 2.7 mg/l. The figure we used for our analysis was 0.8 mg/l; the overall results would not change appreciably throughout the range of MATCs.

Finally, to estimate the distribution of USTs with potential toxic discharges, we calculated a joint frequency distribution for gasoline discharge rate and stream flow. The distribution of floating plume sizes was estimated as before for the risk assessment, based on frequencies of different tank designs and vadose zone types. We assumed that USTs were randomly distributed among stream orders in proportion to the number of stream miles nationwide for each stream order (for example, of the total of about 3.24 million stream miles nationwide, about 1.57 million comprise first order streams; thus 48% of USTs are assumed to potentially affect first order streams).

7.E.2. Results

Exhibit 7.20 presents the results of our analysis. Over the thirty-year simulation period, a very large number of streams of first and second order have the potential to be contaminated by USTs. We estimate that out of a total of 1.4 million USTs, up to 560,000 (39%) will have potentially toxic discharges into first order streams, and about 220,000 are potentially toxic to second order streams over the thirty-year period. Even streams of orders 3 and 4 could be affected, although to a much lesser degree than first and second order streams. Up to 5,000 tanks could damage third order streams and about 130 leaking tanks could affect fourth order streams. Streams higher than fourth order are not affected by leaking UST discharges. Exhibit 7.21 shows the percentage of all streams in each order that could be contaminated, assuming no more than one UST per stream. Although leaking USTs are unlikely to cause direct toxicity to aquatic life in larger streams (which tend to be most important in terms of fisheries and other recreational and commercial values), they have the potential to cause serious damage to a large proportion of the nation's small streams.

Although we made a number of conservative assumptions in our methodology and ignored some important physical phenomena, these preliminary results indicate a real potential problem from leaking underground storage tanks. Moreover, they indicate that reducing leaks from USTs could have a significant benefit in terms of avoiding aquatic ecosystem impacts. More work is needed to define better the extent and severity of the current problem, and the effectiveness of the regulatory options in reducing this problem.

7.F. OPTION AND EXISTENCE VALUE LOSSES

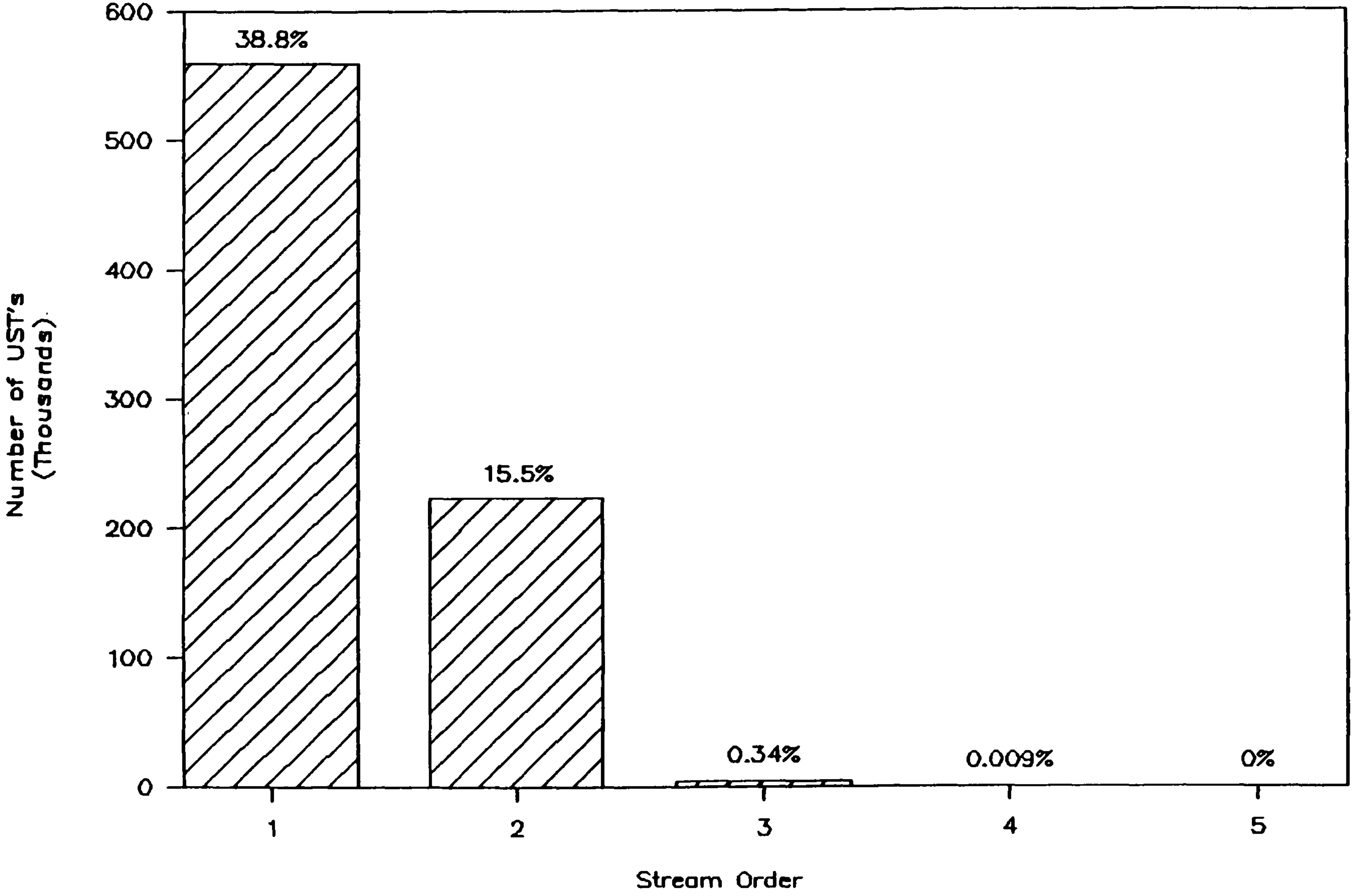
Section 7.D provides dollar estimates of some of the damages borne by individuals and firms whose use of privately or publicly owned facilities, operating at the time of an UST leak, would be impaired by ground water-borne contaminants. While these effects certainly do constitute a portion of the damages due to UST contamination of ground water, there are other categories of damages that also should be considered when evaluating the selection of an UST standard. Because the ground water has been degraded and made unfit for certain uses, there are numerous individuals and firms that don't currently use that water but who are made worse off as a result of the contamination. These additional damages due to an UST leak arise from losses in option value and existence value, values individuals and firms attach to ground water in its original condition.

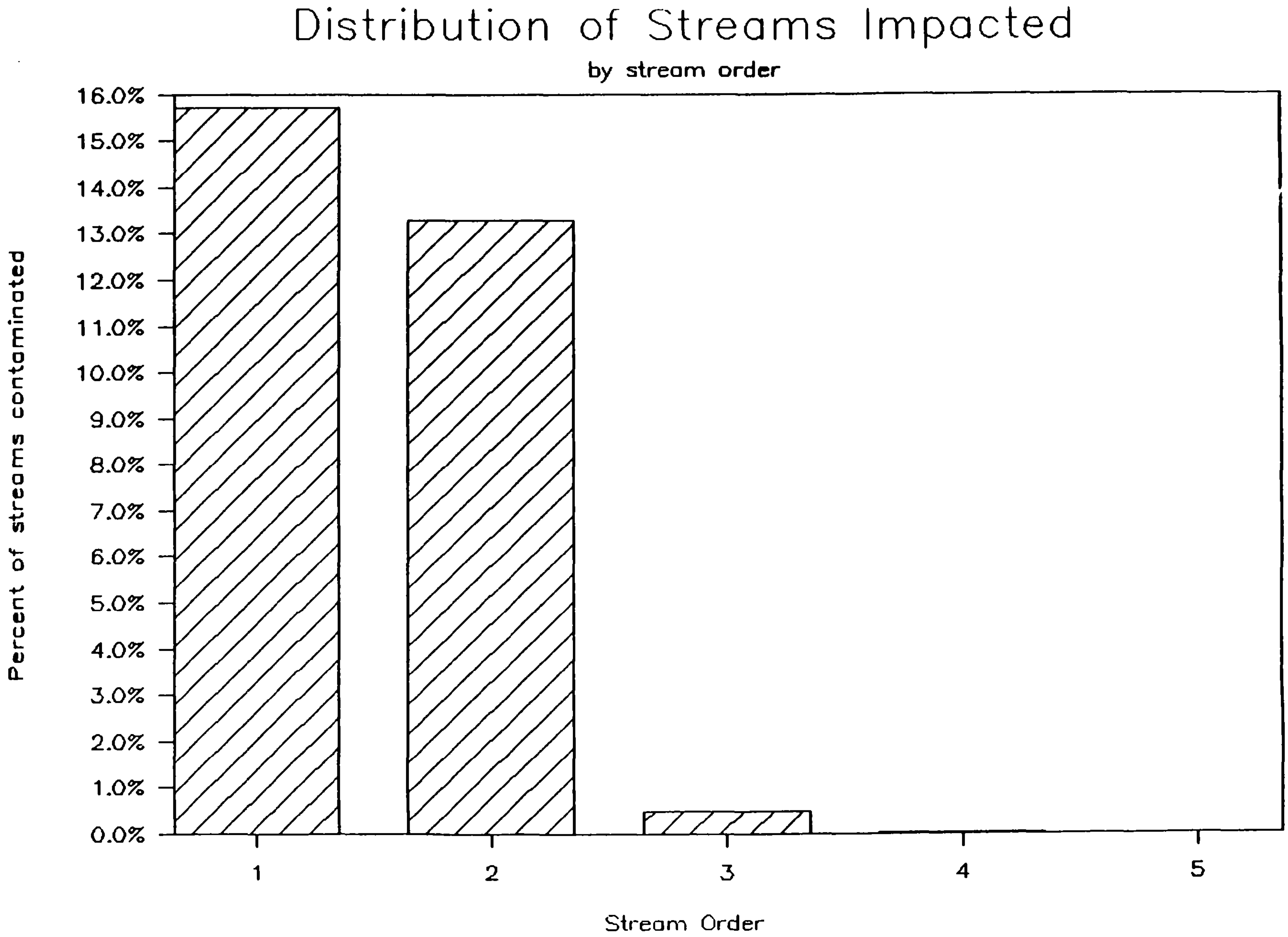
This section of the benefits analysis provides a general description of option and existence benefits as they relate to ground water and UST regulation. Some of the principal factors affecting the magnitude of such benefits are discussed but no quantitative estimates of these benefits occuring from regulating USTs are made.

Exhibi 20

Number of USTs with Aquatic Impacts

by stream order




Distribution of Streams Impacted
by stream order
Percent of streams contaminated
16.0%
15.0%
14.0%
13.0%
12.0%
11.0%
10.0%
9.0%
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
1
2
3
4
5
Stream Order

7.F.1. Origins of Option and Existence Value

We believe it is helpful to think of nonuser damages as originating in the lack of perfected ownership of ground-water resources. If ground water could be owned in a conventional sense, individuals and firms could purchase and sell ground water, and put it to any use they please, including holding it for future use or withdrawing it from use altogether. In such a situation, the differential in the market price for ground water in various places, of various qualities and for different times of use would provide a measure of the damage done, both in the present and in the future, by an UST leak. Of course, ground water is not a conventional good. Either under riparian or prior appropriation law, ownership of ground-water resources is imperfect: the amount, timing, and quality of the ground-water resource claimed are not well established. We believe that some option or existence value is associated with ground water resources but that the lack of perfected ownership prevents complete expression of such values in the marketplace.

7.F.2. Option Value

Option value is derived from the willingness of an uncertain future user of a ground-water resource to pay for an option that would guarantee that the resource, at its current quality and quantity, would be available for future use should the need arise.[1/] Most of the essential notions connected with option value are conveyed by the following illustration. Consider a farmer who wants to retain the option of using ground water for irrigation during periods of low rainfall or runoff, even though he doesn't currently use ground water for that purpose. Indeed, if the farmer values that prospective option, he would be willing to pay some amount today to retain that option in the future, an option that he might never in fact exercise. Other potential users such as households, manufacturers, and municipalities might also be willing to pay to protect their option to use ground water to meet their needs in the future if there were a market in which they could purchase such options. Contamination of ground water from an UST leak deprives these individuals and organizations of the option value they attached to the resource prior to contamination.

How large might option value be? The answer obviously depends on a large number of factors, many of which relate to local hydrologic and economic conditions. First, since the value is associated with possible future use of ground water, current valuation involves discounting the value of such uses to the present. At most discount rates used for benefits analysis, this effectively means that option value on prospective uses with a time horizon of fifty years or greater is virtually zero. The prospective uses must be relatively near at hand in order to contibute much to the benefits of UST regulation. Second, the

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1/ Option value is often defined as the value over and above expected utility in an uncertain setting. In this analysis we include in option value the additional expected utility derived by risk-neutral individuals from the option to participate in a contingent claims market for ground-water resources This characterization of option value seems appropriate in the case of ground-water contamination in as much as ownership conditions that are a prerequisite for the operation of contingent claim markets for ground water have not generally been satisfied.

option value is directly related to the cost of the alternative to the prospective service provided by ground water. For the farmer in the example described above, an inexpensive alternate surface supply would diminish the option value of the ground-water resource. The same reasoning, however, supports a high option value when the ground-water resource is a relatively inexpensive source to produce and essentially non-renewable. Such is the case, for example, for the municipal water supply of El Paso, Texas and the domestic, municipal, and agricultural water supplies of Tucson, Arizona and Roswell Basin of New Mexico.

Option value is also directly related to two probabilities: the probability that the ground water will be contaminated and the probability that the ground water will be used in the future. If the probability of contamination is high initially and will be substantially reduced by an UST regulation, then benefits related to option value will be relatively high. Similarly, if the likelihood that the potential user will desire to use ground water within the next fifty years is high, then the benefits of UST regulation will be commensurately higher.

There are other influences whose effect on option value is more subtle. Generally speaking, the more elastic the derived demand for water resources, the less the option value. This implies that uses whose demand is conventionally regarded as inelastic, such as indoor domestic use, will, all else equal, have higher option values than demand related to those uses which are more elastic e.g., industrial use. Option values for ground water under uncertainty also increase with the risk aversion of the relevant individuals or organizations. Those who are averse to risk will be willing to pay a premium above the expected cost of contamination damage for the chance that the ground water will not be contaminated. Furthermore, an additional, quasi-option value related to a willingness to pay for a delay in putting the ground water at risk may be found for unique ground-water resources where contamination would be irreversible.

There have been few studies valuing ground water or estimating the benefits of preventing ground water contamination e.g., EPA (1985)1/ and Raucher (1986)2/. None that we are aware of specifically estimate option value or aggregate to the national level. Most involve case studies whose value to our analysis is limited by the special conditions of the cases selected and the types of cost and benefit categories employed.

1/ Policy Planning & Evaluation, "Value of Ground Water in Regional Cases," Draft Report to U.S. Environmental Protection Agency, Office of Drinking Water, McLean Va., September, 1986.

2/ Raucher, Robert L., "The Benefits and Costs of Policies Related to Ground-Water Contamination," Land Economics, Vol. 62, No. 1, pp. 33-45, February, 1986.

7.F.3. Existence Value

Existence value has been defined by Krutilla and Fisher as, "the value some individuals place on the knowledge of the mere existence of gifts of nature, even when they feel certain they will never have or choose an opportunity to experience them in situ"1/ (1975, p. 124). The motives underlying existence value, of satisfaction, methods for estimating it, and the relationships between existence value and other measures of value have received much attention in recent resource economics literature. While perhaps a majority of resource economists recognize existence value to be a legitimate component of benefits analysis c.f., Madariaga and McConnell (1985)2/ and Smith and Desvouges (1986)3/, there are those, such as Brookshire, Eubanks, and Sorg (1986)4/ who question the validity of existence value concepts when applied in efficiency-based economic analysis.

By definition, existence value is positive. Within the context of ground water contamination by USTs, existence value is the amount some decision makers are willing to pay to assure the unimpaired existence of a ground water resource. If this is the case, existence values preserved by an effective UST regulation should be added to the other benefits categories associated with the regulation. Omitting such existence values underestimates the benefits of the regulation.

Brookshire, Eubanks and Sorg (1986, pp. 51-2)5/ summarize eleven studies through 1983 that have reported estimates that appear to relate to existence value. These studies all used a contingent valuation framework to produce estimates but employed a wide variety of ways to illicit existence value from respondents. These and most of the more recent studies attempt to estimate existence value for wildlife, special natural environments such as the Grand Canyon, or surface water quality. None that we could find directly addresses the individuals willingness to pay for the existence of a ground-water acquifer uncontaminated by an UST leak. As a consequence, the literature offers no specific guidance as to what the existence benefits of an UST regulation protecting ground water might be.

1/ Krutilla, John V., and Anthony C. Fisher, The Economics of Natural Environments: Studies in the Valuation of Commodity and Amenity Resources, Baltimore, Johns Hopkins Press for Resources for the Future, 1975.

2/ Madariaga, Bruce and K.E. McConnell, Exploring Existence Value, draft prepared for the AERE Workshop on Recreation Demand Modeling, Boulder, Colorado, May 1985.

3/ Smith, V. Kerry and William H. Desvouges, Measuring Water Quality Benefits, Boston: Kluwer-Nijhoff Publishing, 1986.

4/ Brookshire, David S., Larry S. Eubanks, and Cindy F. Sorg, "Existence Value and Normative Economics: Implications for Valuing Water Resources," Water Resources Research, Vol. 22, No. 11, pp 1509-1518, October, 1986.

5/ Brookshire, David S., Larry S. Eubanks, and Cindy F. Sorg, "Existence Value and Normative Economics: Implications for Valuing Water Resources," Water Resources Research, Vol. 22, No. 11, pp 1509-1518, October, 1986.

Chapter 8

IMPLEMENTATION CONCERNS AND SUMMARY COMPARISON OF REGULATORY OPTIONS

This chapter addresses implementation concerns and presents a summary comparison of the five regulatory options presented previously in Chapter 5. This summary comparison draws on the information on costs, effectiveness, economic impacts and benefits presented previously in Chapters 5, 6, and 7. Section 8.A reviews the regulatory options, while Section 8.B discusses implementation concerns. Section 8.C then provides summary data and discussion.

8.A. REVIEW OF REGULATORY OPTIONS

For the reader's convenience, the assumed corrective action policy and the five regulatory options are restated here:

Assumed Corrective Action Policy: Where a release has occured, an investigation of and actions to reduce immediate hazards are followed by limited removal of contaminated soil and removal of any free product from the ground water. The need for more extensive ground water clean up is determined through site-specific exposure and risk assessment. This corrective action policy is assumed to apply to the base case and the regulatory options.

"No Further Regulation" Base Case: assumes no regulation beyond the interim prohibition requirements; existing tanks are mostly bare steel tanks without supplementary detection or inventory control. Tanks found to be leaking are replaced with coated and cathodically protected tanks.

Option I (Baseline level): requires manual inventory control, periodic leak detection within three years for existing tanks (five years for corrosion-resistant tanks), and corrosion-resistance for all replacement (new) tanks. Given that the regulated community is allowed to choose from a variety of detection measures, this option is modeled as though half of all operators choose quarterly vapor well monitoring, and the other half choose to do tank tightness tests every three years (five years for corrosion-resistant tanks). Tanks are assumed to be replaced with coated and cathodically-protected tanks with line leak detectors, and either quarterly vapor well monitoring or a tightness tests every five years.

Option II--The Proposed Rule (Enhanced baseline plus targeted upgrading): is similar to Option I, but requires upgrading to new tank standards within ten years, requires leak detection systems to be sampled monthly rather than quarterly and tightness tests are not required after tanks are replaced. For modeling purposes, operators are assumed to retrofit with cathodic protection and monthly vapor wells to meet new tank standards within eight years of the date that the regulations take affect. New tanks are assumed to be coated and cathodically protected, to have line leak detectors, and to be equipped with vapor wells that are sampled monthly.

Option III (Baseline plus secondary containment for new tanks): requires periodic leak detection for existing tanks and secondary containment with interstitial monitoring for new tanks. For existing tanks, this option is modeled identical to Option I. Replacement tanks are modeled as lined systems with interstitial monitoring.

Option IV (Class Option): requires rapid replacement of existing tanks and secondary containment for replacement tanks at state-designated well-head protection areas.[1] Tanks in other areas are required to conform to baseline standards (Option I). It is assumed that 40 percent of the tank population is located within a well-head protection area. Tanks located in these state-designated areas are assumed to be fitted with continuous vapor wells after one year, and then replaced before the fifth year with protected tanks in liners. The other 60 percent of tanks (those outside well-head protection areas) are modeled the same as Option I. As in other options, ground water is cleaned up at 40 percent of sites where the release has reached ground water; all of these clean ups are assumed to be performed in the well-head protection areas.

Option V (Emphasis on prevention): For existing tanks, this option requires manual inventory control, frequent leak detection starting three years after the regulations take effect, and early retirement. Replacement tanks must have secondary containment. Half of all existing tanks are modeled with continuous vapor well monitoring, and half are modeled with monthly vapor well monitoring and three year tightness tests. Existing tanks are replaced with lined systems either when they fail, or within eight years of the effective date of the regulations.

8.B. IMPLEMENTATION CONCERNS

The cost and feasibility of implementation, both to regulators and to the regulated community, can significantly affect the relative desirability of the options under consideration. Factors to be considered include:

(1) The degree to which a proposal is self-implementing (e.g., the interim prohibition induces tank manufacturers to produce only corrosion-resistant tanks);

(2) The likelihood of compliance;

(3) The costs of ensuring adequate compliance (ease of enforcement);

(4) Capacity constraints inhibiting compliance; and

(5) The extent to which the regulated community can afford compliance costs.

For UST regulatory options, there are interrelationships among prevention, detection, and corrective action that need to be addressed from an implementation perspective. For example, the timing and scope of detection requirements

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1/ Under the requirements set forth in the 1986 Amendments to the Safe Drinking Water Act, states must designate well-head protection areas as part of a complete ground water protection plan in order to receive EPA grants to cover the costs of state ground-water programs. The bill defines a well-head protection area as the "surface and subsurface area surrounding a water well or wellfield supplying a public water system, through which contaminants are reasonably likely to move toward and reach such water well or wellfield".

can significantly affect the timing and magnitude of demands on firms providing leak detection equipment and corrective action and closure services, as well as affect the government entities overseeing corrective action and closure. If, for example, a large number of existing tanks are leaking, immediate requirements for testing would result in significant immediate demands for leak detection equipment and for corrective action services. Prevention-related requirements could have the opposite effect: these requirements could significantly reduce demands on the corrective action program in the long run by reducing the number and size of releases. However, if compliance deadlines for prevention-related requirements are not phased over an adequate period of time, they may impose capacity constraint problems and high initial compliance costs, which in turn may lead to economic dislocation.

Phasing compliance deadlines is one way that regulators can address some implementation concerns. Usually, the longer the phase-in period, the fewer the implementation concerns. This is true because there is more time to resolve capacity constraints, or because compliance can be more easily phased into regular capital replacement and maintenance schedules.

The following discussion of the regulatory options from an implementation perspective is more qualitative than quantitative. Furthermore, the options are only evaluated relative to each other, rather than in an absolute sense. Thus, if an option is shown to have low implementation concerns relative to other options, it does not necessarily follow that the option is easy to implement in an absolute sense. This evaluation is presented below.

Option I (Baseline): This option raises very few significant implementation questions. The requirement that replacement tanks be cathodically protected does not go beyond the statutorily mandated interim prohibition. The interim prohibition probably ensures that very few bare steel tanks will even be manufactured in the future, thus reducing the chances for non-compliance. The detection requirement can be met by a tank tightness test every three to five years, so the rate at which releases are detected is not likely to lead to a short-run capacity problem with respect to corrective action.

Option II (Baseline plus Target Upgrading): This option also raises very few significant implementation questions. The upgrading requirement is phased in over ten years, thus reducing the chance of transitional implementation problems. New tanks need only be corrosion protected, a provision which should be easily self-implemented. This option also allows for retrofitting of cathodic protection and specifies operation and maintenance requirements for cathodic protection. The relative affordability of these provisions should facilitate compliance. Deadlines for meeting leak detection standards are sufficiently phased in so that no serious implementation problems should result.

Option III (Baseline plus Secondary Containment for New Tanks): The secondary containment requirement for new tanks may be difficult to implement because of possible capacity shortages in the tank manufacturing market and shortages in installation expertise even though the need for replacements arises only as existing tanks are found to be leaking. Also, the additional cost of secondary containment may cause potential economic dislocation, and thus hinder implementation. In short, implementation concerns for Option III are estimated to be greater than the implementation concerns for Option II.

Option IV (Class Option): Implementation concerns play a key role in considering this option. Although it seems reasonable for the stringency of a regulation to match the potential magnitude of the problem, implementation of this regulatory approach may be impeded by difficulty and confusion associated with assigning individual facilities to a particular class. Such difficulty and confusion may exist for both the enforcers (federal and state) and the regulated community. Given that there are already regulatory distinctions based on UST contents (petroleum/hazardous substances) and UST type (protected/unprotected), additional distinctions based on tank location may further complicate the regulatory framework. Furthermore, it may take a number of years for well-head protection zones to be sufficiently defined to be used as the basis for UST regulation. These implementation concerns detract from the theoretical attractiveness of this option.

Option V (Emphasis on Prevention): Mandatory tank replacement within ten years potentially exacerbates any capacity problems associated with production and installation of tanks with secondary containment. In addition, the requirement for mandatory replacement and secondary containment for new tanks raises questions of affordability (as discussed in Chapter 6), and therefore could hinder implementation. Also, the provisions for frequent and rapid leak detection raise questions of resource adequacy to meet increased demands for corrective action and tank replacement. In short, it is likely that this option is more difficult to implement than Option II.

8.C. SUMMARY COMPARISONS OF INTEGRATED OPTIONS

This section is presented in five sub-sections as follows:

- o Section 8.C.1 summarizes costs;
- o Section 8.C.2 summarizes effectiveness and benefits;
- o Section 8.C.3 summarizes trade-offs;
- o Section 8.C.4 summarizes economic impacts; and
- o Section 8.C.5 summarizes all key findings

8.C.1. Summary of Costs

Exhibit 8.1 provides summary data on the costs expected to be incurred under the base case and under each of the regulatory options. Costs are provided for prevention and detection (which is defined to include tank acquisition/installation, detection/monitoring, tank removal, and an offset for reduction in product lost), corrective action (assuming EPA's corrective action requirements are applied to each scenario, including the base case), and total costs (sum of prevention/detection and corrective action). Exhibit 8.1(a) provides cost data on a total present value basis (calculated by discounting a future thirty-year cost stream back to the present using a 3 percent discount rate), while Exhibit 8.1(b) presents the same cost data on an annualized basis (smoothing the present value costs over each of the thirty-years using the same 3 percent discount rate).

Exhibit 8.1

SUMMARY OF TOTAL COSTS

(a) Total Present Value Costs

	Base Case	Option I	Option II	Option III	Option IV	Option V
			($ Billions)			
Total PV Cost of Prevention and Detection (1)	$31.0	$33.0	$35.0	$43.0	$45.0	$56.5
Total PV Cost of Corrective Action (2)	89.8	80.9	59.8	75.6	50.1	40.6
Total PV Cost (3)	$120.8	$113.9	$94.8	$118.6	$95.1	$97.1

(1) Cost includes tank acquisition/installation, detection/monitoring, tank removal, and an offset for reduction in product lost. Present Value includes all capital and operating costs expected to be incurred over 30 years, discounted at 3%.

'2) Estimated costs for corrective action in each scenario, assuming EPA's corrective action requirements are applied to each scenario (including the base case).

(3) Total PV Cost of Prevention and Detection + Total PV Cost of Corrective Action.

(b) Annualized Costs *

	Base Case	Option I	Option II	Option III	Option IV	Option V
			($ Billions)			
Annualized Cost of Prevention and Detection	$1.58	$1.68	$1.79	$2.19	$2.30	$2.88
Annualized Cost of Corrective Action	4.58	4.13	3.05	3.86	2.56	2.07
Total Annualized Cost	$6.16	$5.81	$4.84	$6.05	$4.86	$4.95

* Annualized costs derived by smoothing PV costs over 30 years at a 3% discount rate (Annualization factor = 0.051).

Exhibit 8.1 accounts for both capital costs and annual operating and maintenance costs. Because capital expenditures are staggered throughout the thirty-year period, a total present value approach is the preferred approach to account for timing differences. Exhibit 8.1 represents the cost data derived from the runs of the UST Model, and therefore provides the basis for incremental costing of regulatory options, as will be discussed in Section 8.C.3.

Exhibit 8.1 suggests that Options II, IV, and V have the lowest total present value costs, when costs of prevention and detection and corrective action are both considered. However, these three options differ in terms of how total present value costs are distributed between prevention and detection costs and corrective action costs. This is addressed in Section 8.C.3.

8.C.2 Summary of Effectiveness and Benefits

Findings on effectiveness and benefits are summarized in Exhibit 8.2. As discussed in Chapter 5, plume area avoided is a reasonable effectiveness measure on which to compare regulatory options. Although corrective action also mitigates damages, there are damages which occur before cleanup begins, there may be some possibility of residual damages remaining once cleanup has been completed, and there are some feasibility and implementation issues associated with corrective action. Exhibit 8.2 provides data on the plume area that would occur in the base case and under each of the options, and provides the percentage of plume area avoided relative to the base case for each option. The options avoid between 54% and 83% of the plume area associated with the base case.

Benefits data are provided in Exhibit 8.2 with respect to property damage and profits lost, cancer risks, explosion risks, and damage to fish. Property damage and profits lost are provided for the base case and each of the regulatory options. Low, middle, and high estimates are provided for these damages, based on differing assumptions about vapor damages per structure, damages per private well, and damages per public well, as explained in Chapter 7. Data is also provided for cancer risks associated with consuming ground water contaminated with benzene due to a petroleum UST leak. In addition, Exhibit 8.2 shows there are base-case risks due to explosion hazards, as well as base-case risks associated with potential damage to fish. These base-case risks have not yet been quantified, nor have they been analyzed with respect to how the various regulatory options might mitigate them.

In addition to the benefits presented in Exhibit 8.2, there are also the benefits associated with option value and existence value. Although not subject to quantification, some corrective actions are currently undertaken even though damages apparently avoided do not seem to justify the corrective action expenditures. This suggests that option value and existence value can be significant.

Exhibit 8.2

SUMMARY OF EFFECTIVENESS AND BENEFITS

		Base Case	Option I	Option II	Option III	Option IV	Option V
EFFECTIVENESS							
Floating Plume Acres (1)		190,387	86,859	61,886	84,886	61,371	31,465
Percent of Plume Area Avoided (2)		----	54%	67%	55%	68%	83%
BENEFITS							
PV of Property Damage and Profits Lost ($ billions): (3)							
Low Estimate		$2.2	$1.9	$1.6	$1.9	$1.5	$0.9
Middle Estimate		12.7	10.7	9.3	10.7	8.4	5.0
High Estimate		30.4	24.7	21.4	24.7	19.2	11.5
Cancer Risks:							
Percentage of USTs with MEI Risks > 10 -6 (limited by taste & odor threshold)	(4)	7%	2%	3%	2%	0%	2%
Percentage of USTs with MEI Risks > 10 -6 (not limited by taste & odor threshold)	(5)	20%	5%	8%	6%	0%	3%
Explosion Risks		(6)					
Damage to Fish		(7)					

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(1) Floating plume acres is a measure of the quantity of contaminated ground water that would occur under any scenario, (including the base case), given the level of prevention and detection for that scenario.

(2) For each option, calculated as ((Plume Acres in Base Case) - (Plume Acres under Option)) / (Plume Acres in Base Case).

(3) Present value of property damage and profits lost due to plumes occuring in that scenario (including base case). Low, medium and high estimates derived by adjusting estimates of vapor damages per structure, damages per private well, and damages per public well (see Chapter 7).

(4) Percentage of USTs where the most exposed individual has a risk greater than 10 -6 of contracting cancer due to lifetime consumption of ground water contaminated with benzene due to a petroleum UST leak (assuming that consumption stops when the taste or odor threshold is reached).

(5) Percentage of USTs where the most exposed individual has a risk greater than 10 -6 of contracting cancer due to lifetime consumption of ground water contaminated with benzene due to a petroleum UST leak (assuming that consumption is not limited by the taste or odor threshold).

(6) The Release Incident Survey documented 141 fire and explosion incidents out of a total of 10,000 reported release incidents, though the risk of death or injury is not known.

(7) Concentrations of gasoline as low as 0.005 mg/l can cause organoleptic effects (bad tastes or smells) in fish, impairing commercial and recreational fishing.

8.C.3. Summary of Trade-offs

Exhibit 8.3 provides a summary of relevant trade-offs. Exhibit 8.3(a) presents the trade-off between costs of prevention and detection with corrective action costs avoided. As stated previously, corrective action costs avoided in some ways represent the savings of improved prevention and detection. After reviewing the cost data for the base case and each regulatory option already presented in Exhibit 8.1, Exhibit 8.3(a) presents incremental prevention and detection costs and incremental corrective action costs avoided relative to the base case.

Exhibit 8.3(a) shows that Option I entails $2.0 billion in incremental prevention and detection costs, which result in an incremental $8.9 billion in corrective action costs avoided, relative to the base case, or a net savings of $6.9 billion. Similarly, Option II entails $4.0 billion in incremental prevention and detection costs, which result in $30.0 billion in corrective action costs avoided, relative to the base case, or a net savings of $26.0 billion. Thus, both Options I and II provide net savings when viewing the basic trade-off in this manner. Relative to Option I, Option II includes an incremental $2.0 billion in prevention and detection costs, but yields an incremental savings of $21.1 billion in corrective action costs.

However when the trade-off is viewed in this manner, Options III, IV, and V do not provide net savings relative to Option II. Option III entails greater incremental costs for prevention and detection than Option II, yet does not produce the same level of incremental corrective action costs avoided. Option II therefore clearly dominates Option III. It is less clear whether Option II dominates Options IV and V, however, because there is less of a difference between them in net savings from the base case. Therefore, additional dollars spent on prevention and detection in Options IV and V just about pay for themselves in terms of corrective action costs avoided.

Exhibit 8.3(b) displays the trade-off between prevention and detection costs and plume acres avoided, not taking corrective action costs into account. When using plume acres avoided as the effectiveness criterion, Option III is still dominated by Option II because Option III avoids fewer plume acres than Option II for a greater incremental cost. In addition, it seems reasonable to assume that Option IV is dominated by Option II when using plume acres avoided as the effectiveness criterion, because Option IV produces roughly the same level of incremental plume area avoided as Option II, but at a greater incremental cost of prevention and detection.[1]/ Option V has the highest incremental cost of prevention and detection and avoids the most plume area. However, the cost per additional plume acre avoided associated with Option V is much higher than the cost per additional plume acre avoided associated with Option II. Comparisons between these options also depend on findings from the analysis of implementation concerns and economic impacts.

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[1]/ Because Option IV requires greater levels of prevention and detection in state-designated well-head protection areas, it produces fewer plumes acres in these areas, while perhaps allowing more plume acres in other areas. Thus, it is reasonable that Option IV avoids corrective action costs (because the most extensive corrective actions would occur in well-head protection areas), but not necessarily plume acres, relative to Option II.

Exhibit 8.3

TRADE-OFFS

(a) Cost of Prevention & Detection vs. Cost of Corrective Action Avoided

	Base Case	Option I	Option II	Option III	Option IV	Option V
PRESENT VALUE COSTS			($ Billions)			
1. PV Costs of Prevention and Detection	$31.0	$33.0	$35.0	$43.0	$45.0	$56.5
2. PV Costs of Corrective Action	89.8	80.9	59.8	75.6	50.1	40.6
3. Total PV Cost (Row 1 + Row 2)	$120.8	$113.9	$94.8	$118.6	$95.1	$97.1
INCREMENTAL COST FROM BASE CASE						
4. Incremental Costs of Prevention and Detection	----	$2.0	$4.0	$12.0	$14.0	$25.5
5. Incremental Corrective Action Costs Avoided	----	8.9	30.0	14.2	39.7	49.2
6. Net Savings (Row 5 - Row 4)		$6.9	$26.0	$2.2	$25.7	$23.7

(b) Cost of Prevention and Detection vs. Plume Acres Avoided

	Base Case	Option I	Option II	Option III	Option IV	Option V
Incremental PV Costs of Prevention and Detection (from base case) ($ billions)	----	$2.0	$4.0	$12.0	$14.0	$25.5
Incremental Percent Plume Area Avoided (from base case)	----	54%	67%	55%	68%	83%
Incremental Plume Area Avoided (from base case) (acres)	----	103,500	128,500	105,500	129,000	159,000

8.C.4. Summary of Economic Impacts

Economic impacts associated with the regulatory alternatives have been addressed in Chapter 6 and are summarized in Exhibit 8.4. The economic impact analysis focused on the retail motor fuel industry because: (1) there are no substitutes for USTs in retail motor fuel marketing, (2) UST costs represent a significant fraction of capital and operating costs for these facilities, and (3) there are many small establishments. Exhibit 8.4 presents projected exits within the first five years of regulation for retail motor fuel outlets owned by small firms under each of the regulatory options. Exit projections under an assumption of no revenue increase are presented in Exhibit 8.4(a), and Exhibit 8.4(b) provides a projection for Option II under a 3 percent revenue increase.1/

The data in Exhibit 8.4(a) first indicate that under a no revenue increase assumption, 19 percent of outlets owned by small firms would naturally exit in the first five years. Exhibit 8.4(a) further indicates little difference between Options I, II, and III in expected economic impacts on small firms owning retail motor fuel outlets. Tank replacement or upgrade costs eliminate 2 percent of these firms under each of these options. Although the secondary containment requirements for new tanks in Option III might be expected to produce relatively more exits, the fact that, under this option, replacement need not occur until leaks are detected suggests that corrective action costs will produce the exit. In fact, under all three of these options, corrective action burdens are projected to cause an additional exit of approximately 56 percent of these small firms in the first five years under the (worst case) no revenue increase assumption.2/

In the case of options IV and V, a higher proportion of the total exits are due to the tank replacement or upgrade requirements. In the case of Option IV, exit due to tank replacement and upgrade is 15 percent while exit due to corrective action is 39 percent. Under Option V, exit due to tank replacement or upgrade is 41 percent while corrective action-induced exit is 22 percent.

Exhibit 8.4(b) provides some indication of the effects of relaxing the no revenue increase assumption. A 3 percent revenue increase assumption is used because, as Chapter 6 suggests, such a level would be adequate for larger firms to remain sufficiently profitable. The exhibit suggests that potential economic impacts are somewhat mitigated by relaxing the no revenue increase assumption. If the 19 percent natural exit assuming no revenue increase is subtracted from the 37 percent exit due to corrective action assuming a 3 percent revenue increase, incremental exit due to the proposed rule is 18 percent. Should a revenue increase greater than 3 percent occur, survival rates under Option II are projected to approach base case survival rates in ten years, as discussed in Chapter 6. Only Option II has been run under a revenue increase assumption.

1/ Revenue increases can occur due to increases in price or quantity. Arguments have been presented in Chapter 6 that the fixed cost nature of compliance costs mitigates the likelihood of compliance costs being passed forward in the form of increased prices. However, as outlets close, it is not unreasonable to expect quantity demanded to be redistributed among remaining outlets.

2/ Chapter 6 suggests that profitability in larger firms (excluding large oil companies) could also be significantly affected by corrective action burdens under assumptions of no revenue increase.

Exhibit 8.4

SUMMARY OF ECONOMIC IMPACTS

(a) Cumulative Percentage of Outlets Owned by Small Firms Exiting Through Year Five **
(Assuming No Revenue Increase)

	Option I	Option II	Option III	Option IV	Option V
Natural Exit Through Year 5 (1)	19%	19%	19%	19%	19%
Exit - Tank Replacement or Upgrade Through Year 5 (2)	2%	2%	2%	15%	41%
Exit - Corrective Action Through Year 5 (3)	52%	50%	52%	39%	22%
Total Exit Through Year 5	73%	71%	73%	73%	82%

(b) Cumulative Percentage of Outlets Owned by Small Firms Exiting Through Year 5
Assuming a 3% Revenue Increase (Option II only)

Exit - Tank Replacement or Upgrade Through Year 5	0%
Exit - Corrective Action Through Year 5	37%

** Small firms in the retail motor fuels marketing sector are defined as having annual sales less than $4.6 million.

(1) Based on extrapolation of past exit rate trends for outlets owned by small firms.

(2) Exit caused by leak detection, replacement of leaking tanks, and mandatory tank retirement or upgrading costs.

(3) Exit caused by corrective action costs.

8.C.5 Chapter Summary

This chapter has drawn from all previous chapters in this analysis to present a summary of the key findings. These key findings are condensed into Exhibit 8.5. The key findings can be summarized as follows:

- All of the options are substantially effective in mitigating the problems associated with the base case. The options avoid between 54 percent and 83 percent of the plume area associated with the base case. Plume area avoided is a reasonable measure of effectiveness because the alternative, corrective action costs avoided, does not eliminate all damages associated with plumes.

- When viewing the basic trade-off as costs of prevention and detection versus corrective action costs avoided, the proposed rule (Option II) dominates Option I and III. Relative to the base case, Option II produces more corrective action savings than Option III at a lower cost of prevention and detection. Relative to Option I, Option II produces approximately $21 billion in incremental corrective action costs avoided for an incremental investment of $2 billion in prevention and detection.

- Option II does not necessarily dominate Options IV or V when viewing the basic trade-off as above. The extra dollars spent on prevention and detection in Options IV and V just about pay for themselves in terms of corrective action cost savings. This is the case because Options II, IV, and V all produce about the same level of net savings from the base case.

- However, Option IV has the most serious implementation concerns associated with it because of it requires classification of UST locations classes. Option V has the most significant potential economic impacts for prevention and detection, because of high costs associated with mandatory replacement of existing tanks with tank systems utilizing secondary containment. Option V also raises questions of capacity with respect to producing and installing tank systems utilizing secondary containment.

- In general, the potential for significant economic impacts associated with corrective action costs suggests that the undertaking of corrective action measures may sometimes be impeded by affordability considerations. Firms that go out of business will not be able to cover the full cost of the corrective action measures needed.

- Any and all analytical results must be viewed in the context of the limitations of this analysis. These limitations are addressed in Chapter 9.

Exhibit 8.5

SUMMARY OF EFFECTS

	Base Case	Option I	Option II	Option III	Option IV	Option V
INCREMENTAL COSTS FROM BASE CASE						
1. Prevention and Detection Costs ($ billions)	----	$2.0	$4.0	$12.0	$14.0	$25.5
2. Corrective Action Cost Savings ($ billions)	----	8.9	30.0	14.2	39.7	49.2
3. Net Savings ($ billions) (Line 2 - Line 1)		$6.9	$26.0	$2.2	$25.7	$23.7
EFFECTIVENESS RELEATIVE TO BASE CASE						
4. Percent of Plume Acres Avoided	----	54%	67%	55%	68%	83%
5. Total Plume Acres Avoided	----	103,500	128,500	105,500	129,000	159,000
CLOSURES ASSUMING NO REVENUE INCREASE						
6. Percent of Retail Petroleum Outlets Owned by Small Firms Closed in First 5 Years Due to Tank Replacement	----	2%	2%	2%	15%	41%
7. Percent of Retail Petroleum Outlets Owned by Small Closed in First 5 Years Due to Corrective Action Cost	----	57%	55%	56%	43%	17%
CLOSURES ASSUMING A 3% REVENUE INCREASE						
8. Percent of Retail Petroleum Outlets Owned by Small Firms Closed in First 5 Years Due to Tank Replacements			0%			
9. Percent of Retail Petroleum Outlets Owned by Small Closed in First 5 Years Due to Corrective Action Costs			41% (1)			
IMPLEMENTATION CONCERNS						
10. Relative Comparisons	----	low	low	medium	high	medium

(1) If the expected 19% natural exit assuming no revenue increase is subtracted from the 41% exit due to corrective action, assuming a 3% revenue increase, incremental exit due to the proposed rule is 22%. Under a 3% revenue increase, there would be no natural exit.

Chapter 9

LIMITATIONS OF THE ANALYSIS

9.A. UNCERTAINTIES IN ASSUMPTIONS, DATA, AND METHODOLOGY

9.A.1. Overview of Uncertainties

The problems of discerning the damages caused by leaking USTs, of designing a regulatory response to these damages, and of measuring the expected effects of the response are technically very complex. A complete understanding of tank systems and the risks they pose requires a tremendous amount of knowledge in a large number of fields. In many instances the regulatory analysis must proceed on the basis of partial information and estimates or assumptions derived from the data that is available. The conclusions of the analysis, as a result, will be subject to limitations caused by uncertainties with available data and the realm of error implicit in the assumptions.

In this chapter, we describe the most important areas of uncertainty in the analysis and identify the major limitations of our analysis. Many uncertainties are the result of data limitations due to our inability to model phenomena that cannot be observed in the real world. Other uncertainties can be attributed to limitations implicit to the modeling approach. To the extent that there is uncertainty with available data and in the assumptions, there is uncertainty in the analysis and in the results of the analysis. However, any comprehensive analysis that attempts to accomplish the same results will face most of these same limitations.

9.A.2. Uncertainties in the UST Model

9.A.2.a. Uncertain Data Inputs

The ability of the UST model to estimate the extent of the current problem and to predict the effects of proposed regulations depends, as discussed in Chapter 2, on the quality of the data used to estimate the failure probabilities and other model parameters and inputs. The data are imperfect, and so the model cannot track reality with precision.

In order to simulate the failure probabilities of underground storage tanks and the resultant effects, or consequences, of leaking tanks, a great deal of information regarding the current state of the existing tank population is needed. Due to the size and diversity of the existing UST universe and our inability to observe the release and transport of product from a leaking tank, much of the data needed to accurately model tank failures is unavailable. We do have estimates of the numbers and types of tanks and estimates of tank locations and densities. By combining this information with engineering estimates of the physical properties of tank materials, the effectiveness of leak detection, and the behavior of stored product once it is released into the environment, EPA has developed a model that reasonably simulates actual events. Because the UST Simulation Model was developed and calibrated using limited available data and best estimates of probable events, uncertainty is injected into all areas of the analysis; and therefore, the results of the analysis can be viewed only as estimates of present and future events and not as exact reflections, or precise predictions, of these events.

9.A.2.b. Phenomena Not Addressed by the Model

The modeling process allows us to consider only a limited number of factors. The simulated tank system is a simplified version of a real system. We model what we consider to be the most important phenomena; but by excluding even the most minor of events or the least likely situations, we bias the probabilities of simulated occurances and increase the likelihood of the model estimates deviating from the true probabilities of actual events. By using the best data available and by drawing assumptions from expert knowlege and best engineering judgement, we can limit the amount of error introduced into the analysis, but we cannot eliminate it. One advantage of the UST Model is that it requires that assumptions and data be used in an explicit and consistent manner. When there is uncertainty about particular assumptions used in the analysis, we use the model to conduct sensitivity analyses to make the importance of the uncertainty clear or to provide a range of possible values rather than a point estimate of a parameter or event.

At present, we use the UST Model to simulate USTs containing gasoline. We estimate failure probabilities and probable damages assuming all underground storage tanks contain gasoline. The lack of accurate, or detailed, information currently prevents us from modeling other petroleum products and hazardous substances. Other phenomena not covered by the model include: variations in the location of the leak within the tank (we assume all leaks occur at the bottom of a tank); early tank retirement not due to tank system problems when unprofitable stations close; fractured flow aquifers; multi-layer aquifers; and false positive readings from detection methods other than tightness tests. Other events which are not modeled explicitly, but are accounted for through the calibration of model inputs or assumptions include: off-site leak detection due to sheens on surface water; leak detection by noticing a decrease in a facility's profitability over months or years, and leak detection by happenstance or by (human) sensory detection. Each of these small gaps in the model adds to our uncertainty over the model results and limits the accuracy of our analysis.

9.A.3. Uncertainties in Benefits Analysis

9.A.3.a. Unmodeled Aspects of Fate and Transport

The benefits analysis of the UST regulation is driven by estimates of the concentrations of contaminants released from leaking tanks over time and at different distances from the tanks. These estimates, in turn, are based in part on results from the UST Model, and on modeling techniques and assumptions outside the scope of the UST Simulation Model. Some of the important phenomena that affect concentration estimates that are not part of the UST model include: degradation; interception by surface water; transport of released product through the atmosphere; exposure assumptions (i.e., the number of wells and water users found at given distances from USTs); and the prevalence of the use of less-vulnerable confined aquifers for drinking water. Significant uncertainty remains over the best way to model these phenomena, meaning that estimates of exposure concentrations are subject to significant uncertainty.

9.A.3.b. Toxicological Issues

Another important element of the benefits analysis is the prediction of health impacts given exposure levels. Though we believe we identified the most dangerous components of gasoline with respect to carcinogenic potential, there may be components whose ability to cause cancer is unknown. There may also be noncarcinogenic effects, as yet unidentified, from gasoline at the doses likely to be encountered near leaking USTs. To the extent that noncarcinogenic effects exist, the damages from leaking USTs are underestimated and the benefits of regulatory alternatives are, therefore, underestimated in this analysis.

9.A.3.c. Nonhealth Benefits

Even more uncertainty exists over the magnitude and frequency of nonhealth damages. These include both the value of preventing tangible property damage, as well as the value of preventing less tangible non-market damages--damage to option value, for example. Uncertainties in estimating nonhealth benefits can be attributed to difficulties in observing nonhealth damages and in measuring the value, or cost, of such damages. It is difficult to identify the incremental change in the market value of property due to damages from leaking USTs. It is also difficult to estimate the value that currently unused resources may have in the future.

9.A.4. Uncertainties in Economic Impact Analysis

9.A.4.a. Uncertainties in the Regulatory Base Case

Measuring the costs of regulatory alternatives relative to what would prevail in the absence of federal intervention requires estimating what would prevail in the base case. The base case is difficult to characterize because there are thousands of facilities which employe different leak detection and inventory control practices. This diversity in operating practices introduces uncertainty with respect to the resources that may be expended in avoiding and detecting leaks, and in responding to detected leaks in the absence of regulatory intervention. The degree of uncertainty inherent in estimating market behavior and future trends in market prices limits our ability to accurately estimate the costs of the regulatory alternatives.

9.A.4.b. Uncertainties in Regulatory Costs

Cost estimates for regulatory proposals are based on current technologies and market conditions. However, it is possible that an increased market for leak prevention, detection, and cleanup technologies and services could induce changes in market prices. Price changes may occur as a result of: short term scarcity due to industry capacity constraints in supplying needed products and services; innovation and diffusion of new technologies; and economies of scale as demand growth allows fuller utilization of production capacity. Another uncertainty is the path of future gasoline prices and the prices of other substances stored in USTs. The current average price of gasoline is used to measure the value of product loss resulting from leaks.