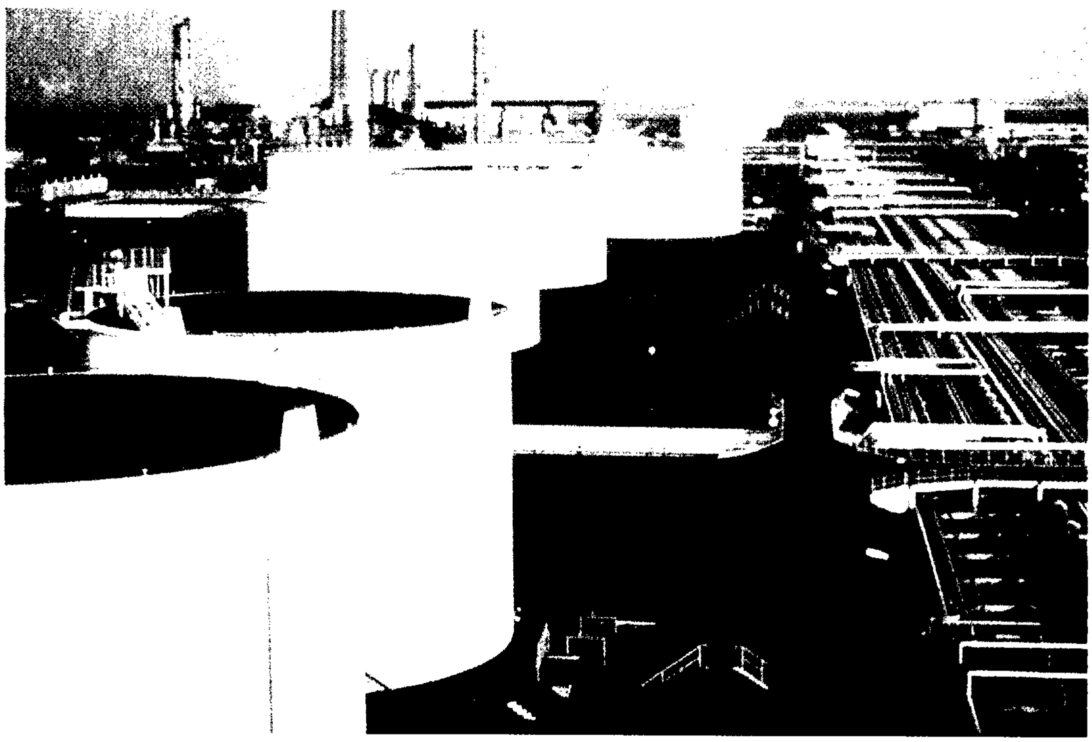

A Survey of Diked-Area Liner Use at Aboveground Storage Tank Facilities

Health & Environmental Affairs Department
Publication Number 341
February 1998

American Petroleum Institute

STEP Strategies for Today's Environmental Partnership

American Petroleum Institute

American Petroleum Institute Environmental, Health, and Safety Mission and Guiding Principles

MISSION

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

PRINCIPLES

- To recognize and to respond to community concerns about our raw materials, products and operations.
- To operate our plants and facilities, and to handle our raw materials and products in a manner that protects the environment, and the safety and health of our employees and the public.
- To make safety, health and environmental considerations a priority in our planning, and our development of new products and processes.
- To advise promptly, appropriate officials, employees, customers and the public of information on significant industry-related safety, health and environmental hazards, and to recommend protective measures.
- To counsel customers, transporters and others in the safe use, transportation and disposal of our raw materials, products and waste materials.
- To economically develop and produce natural resources and to conserve those resources by using energy efficiently.
- To extend knowledge by conducting or supporting research on the safety, health and environmental effects of our raw materials, products, processes and waste materials.
- To commit to reduce overall emission and waste generation.
- To work with others to resolve problems created by handling and disposal of hazardous substances from our operations.
- To participate with government and others in creating responsible laws, regulations and standards to safeguard the community, workplace and environment.
- To promote these principles and practices by sharing experiences and offering assistance to others who produce, handle, use, transport or dispose of similar raw materials, petroleum products and wastes.

A Survey of Diked-Area Liner Use at Aboveground Storage Tank Facilities

Health and Environmental Affairs Department

API PUBLICATION NUMBER 341

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American Petroleum Institute

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EXECUTIVE SUMMARY

In 1997, the American Petroleum Institute (API) conducted a survey on the use of diked-area liners around aboveground storage tanks. The data indicate that the effectiveness of liners in protecting the environment is limited because liner systems frequently fail. Further, the resulting data indicate that there are few releases from aboveground storage tanks that would be addressed by diked-area liners. In addition, liner systems are expensive to install and maintain.

Several states have enacted requirements to install liners within the tankfield diked area during the past decade. However, there is little published information on the performance of diked-area liner systems once installed. Because such liners are costly and because changes must be made to facility operations to accommodate the liner system, API members decided to gather information on the performance of diked-area liners after installation.

API's Storage Tank Task Force conducted a survey designed to evaluate the effectiveness of diked-area liner systems and document operational problems involved with their use. Responses were received from 32 facilities in the marketing and transportation sectors of the petroleum industry.

The data show that liner systems are frequently damaged by day-to-day operations and, thus, would be ineffective in containing a liquid release. Twenty-nine facilities or 91 percent of respondents indicated that the liner system had failed to maintain its integrity over time. Among the responding facilities, however, there were few releases of the type that would be addressed by diked-area liners. Ninety-one percent of all responding facilities indicated there had been no release since the liner had been installed. Because there were few releases, the data do not directly demonstrate the effectiveness or ineffectiveness of liner systems in containing releases.

Eighty-eight percent of respondents indicated that they thought there were alternatives to diked-area liners that would be more effective at protecting the environment. The survey data indicated that operators would prefer to use preventive measures, which are generally more effective in terms of both cost and environmental protection. API survey data also indicated that operators prefer flexible, multi-option approaches, such as those contained in API standards.

The data collected by the API survey led to the conclusion that diked-area liners are not the most efficient means of protecting the environment given

- the tendency of liner systems to fail under day-to-day operating conditions;
- the difficulty of assuring liner integrity;
- the limited benefit derived from the system in addressing oil discharges; and
- the high costs associated with installing, as well as operating and maintaining the liner system.

Measures that prevent aboveground storage tank releases are more effective in protecting the environment and are more cost-effective in the long run.

INTRODUCTION

Over the past ten years, several states have enacted requirements to install liners within the tankfield diked area. These requirements are designed to reduce the permeability of the diked area and contain material in the event of a release. However, there is little published information on the performance of liner systems once installed. Because such liners are costly and because changes must be made to facility operations to accommodate the liner system, API members decided to gather information on the performance of diked-area liners after installation.

BACKGROUND

To accomplish this task, API's Storage Tank Task Force conducted a survey designed to evaluate the effectiveness of diked-area liner systems and to document any operational problems. The survey requested information in three primary areas:

- The effectiveness—or potential effectiveness—of the liner in containing releases;
- The effect of the liner on storage facility operations; and
- Preferred approaches to release prevention.

The survey did not collect information on undertank liners.

SPEC Consulting, an independent firm, was hired to conduct the survey, which was sent to all companies represented on the Storage Tank Task Force. The total number of lined facilities operated by Storage Tank Task force members is unknown; therefore, it is not known what percentage of the population the respondents represent.

Participation in the survey was voluntary, and facility names were kept confidential. No instructions were given to potential respondents regarding number of facilities to include or location of facilities. Because there are no federal requirements and few states require diked-area liners, a wide geographical distribution of responses was not obtained. Additionally, given the limited nature of the survey, it was not possible to extrapolate from survey findings.

Responses were received from 32 wholesale distribution terminals—operated by 13 companies—storing gasoline and distillate products. Twenty-nine of the liner installations were retrofit around existing tanks; three of the liners were installed as the tanks were being constructed. In general, the lined area ranged from one to ten acres (four facilities reported lined dikes greater than ten acres, and four facilities reported lined dikes of less than one acre). The lining material used at the facilities included clay geo-composites, extruded sheet, spray-on coatings, coated fabric and others.

The survey was confined to petroleum storage facilities due to the unique requirements associated with applying this technology at these sites. While there is an abundance of

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experience available in the use of liners for waste management in landfills and surface impoundments, these applications do not lend themselves well to petroleum storage facility operations. A liner at a landfill is used for constant containment and bears a continual load; a liner at a storage tank facility may be used only rarely. Additionally, a landfill liner will have few or no penetrations. Installing a storage tank liner, however, requires cutting the material and fitting it around piping, conduits, pipe supports, pump foundations, cathodic protection cables and other equipment. Further, landfills have little or no traffic in the containment area. Petroleum storage facilities, on the other hand, require routine vehicular access for ongoing construction, operation, and maintenance activities.

SURVEY FINDINGS

The following outlines major findings in the three areas of interest: effectiveness of the liner, effect on facility operations, and alternatives to diked-area liners. The survey questions and tabulated responses are contained in Appendix A.

Liner System Effectiveness

The reliability of a liner system and its effectiveness in containing releases were two factors evaluated by the survey to determine the system's overall efficiency.

Reliability

The data showed that liner systems frequently fail, implying that the liner could potentially be ineffective in containing a liquid release. Twenty-nine facilities or 91 percent of respondents indicated that the liner system had failed in some manner.

The major categories of failure included:

- Damage from vehicular traffic. At larger facilities, vehicle access may be required for daily operation and routine inspection. Additionally, equipment and material must be brought into the diked area for operation and maintenance activities such as painting, applying internal coatings, and sandblasting.

- Material failure. Reported material failures included chemical decomposition from exposure to stored products, reaction with cover soils, and deterioration from weather. Exposure to sunlight and freezing can cause liner material to thin, shrink, and become brittle. These conditions can lead to seam separation and tearing of the material. Additionally, activities required for maintenance of piping and cathodic protection systems may inadvertently cut or rip the liner.

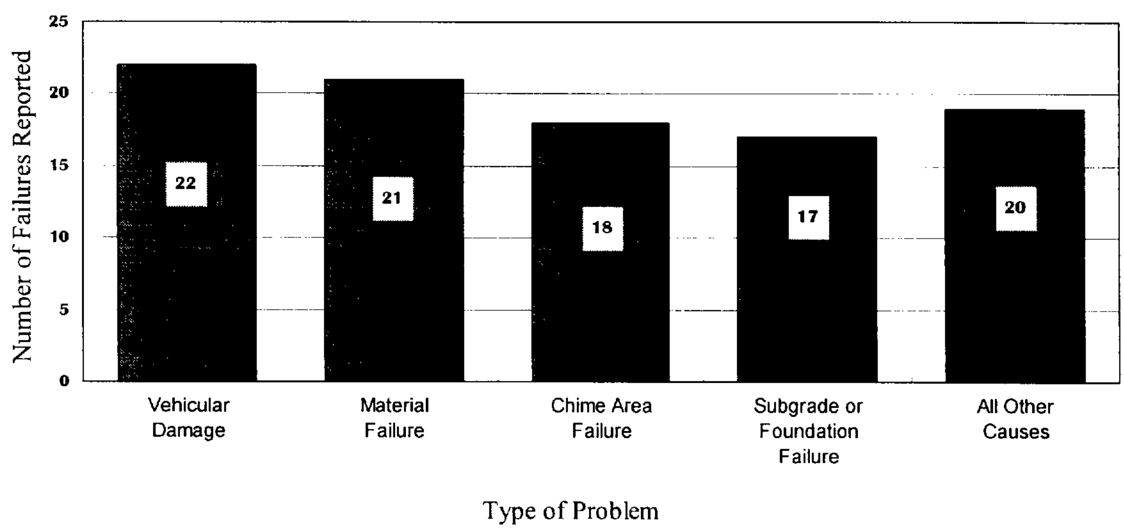
- Failure of the liner around the tank base (or chime area). Structurally, this is a critical area of the tank and its foundation. Fitting and sealing the liner to the tank chime is difficult, and tanks may settle and shift with time. As a result, liner systems frequently fail along the tank perimeter.

- Subgrade failure. Soil compaction and the slope of dike walls affect liner installation and subsequent performance. If the bed of the diked area is not properly compacted, the soil will settle, placing stress on the liner material. Soil settlement can also cause liner material to pull away from the tank chime (or the projection of the floor plate beyond the tank shell). Additionally, if the slope of the dike is too steep, the liner material may slip off the wall, and protective stone or earthen cover will not remain in place.

Other issues reported by facilities included safety concerns, such as slippery liners and spray-on coating failure. High tides or rising groundwater can lift the liner from underneath, potentially damaging the liner system. Installing liners is extremely difficult in tank farms with rising groundwater or tides.

The figure presented below shows the major causes of liner failure and the number of times a failure category was reported by a responding facility.

Figure 1 - Major Causes of Liner Failure



These findings are confirmed by the New York State Department of Environmental Conservation (NYSDEC). In a 1993 memorandum addressing inspection certification of secondary containment systems, NYSDEC noted the difficulty in ensuring performance and verifying the integrity of diked-area liners. The document states that "all secondary containment systems are exposed to numerous physical and environmental conditions which can render a system faulty. Spray-on liners are subject to puncturing. Clay liners are prone to desiccation and cracking in dry environments. Frost or vehicular traffic may cause damage to the liner material."

The memorandum also notes that "problems of design such as short-life materials or construction and compatibility with petroleum have caused a number of secondary containment system failures." The NYSDEC memorandum goes on to discuss the problems and engineering approaches associated with the inspection and evaluation of various liner systems.

API's data indicated that it is difficult to test the containment system after liner installation. Visual inspections are not reasonable for liners that are covered with soil or stone. Maintaining diked-area liners is complicated by the fact that there are no methods for assuring integrity.

<u>Effectiveness in Containing Releases</u>

Survey respondents indicated that few releases had occurred at their facilities that would be addressed by diked-area liners. Twenty-nine facilities or 91 percent of all responding facilities indicated there had been no release since the liner had been installed. Twenty-seven facilities or 84 percent of responding facilities reported that the liner system had been in use for five years or more, and of this subset, 93 percent reported that there had been no release into the diked area during that time period.

Because there were few releases, the data do not directly demonstrate the effectiveness or ineffectiveness of liner systems in containing releases. Only three facilities experienced a release after the liner was installed. Two of these facilities reported that the liner system contained the release; one indicated that the liner did not contain the release. In the latter case, the liner system failure was attributed to improper installation.

<u>Effect on Facility Operations</u>

Twenty-eight or 88 percent of responding facilities indicated that the liner system had adversely affected facility operation. The three major areas of concern were:

- Limited access to the tank farm (because of potential damage to the liner from vehicular traffic). Over the lifetime of a tank, access is needed for operating, inspecting and maintaining the tank. Constant care must be taken not to damage the liner during routine operations and maintenance.

- Increased storm water management or handling because of water accumulation in the diked area. Prolonged exposure to water can accelerate corrosion of the tank.

- Facility components buried under the liner material (e.g., piping, conduits, cables and anodes). These are difficult and impractical to access for operation, inspection or maintenance.

Preferred Approaches to Release Prevention

The data indicated that most facilities installed liners because of regulatory requirements. Only five facilities or 16 percent of respondents indicated that the decision to install the liner was made independently of regulatory requirements. Conversely, twenty-eight or 88 percent of respondents indicated there were alternate approaches that would better protect the environment.

Twenty-seven facilities or 84 percent of respondents indicated that the liner was installed because of regulatory requirements. The majority of responding facilities are located in New York where requirements for the diked area were established in 1985 and became effective in 1990. Florida also has requirements to install diked-area liners by 1999, and some companies have started installing them. The table below, shows the location of responding facilities.

Table 1 - Location of Responding Facilities

Location by State	Number of Facilities
New York	22
Florida	4
Illinois	1
Maryland	1
Michigan	1
New Mexico	1
Virginia	1
Wisconsin	1
Total	32

The survey data indicated that operators would prefer to use preventive measures rather than installing diked-area liners. Generally, operators think that measures to prevent releases are the most effective in terms of both cost and environmental protection. Operators believe that an inspection and maintenance program designed to prevent a tank release is more effective than installing an impermeable liner in the tankfield. The data showed that diked-area liners are prone to damage and thus have limited effectiveness in mitigating liquid releases.

There are a variety of approaches that can be used to offset each release scenario. API's *Liquid Release Prevention and Detection Measures for Aboveground Storage Facilities* (API Publication No. 340) addresses facility tanks, piping, loading/unloading areas, and ancillary equipment. For each of these components, the report provides a summary of potential causes of liquid petroleum releases and gives an overview of the procedures and equipment available to operators to prevent, detect or provide environmental protection from such releases. The executive summary to the release prevention report is reproduced in Appendix B.

API survey data indicated that operators prefer a flexible, multi-option approach. The Department of Transportation, in its recent proposal addressing aboveground tank operations, advocates tank protection through the application of methods outlined in API standards. A preventive program as outlined by API standards would:

- Construct, inspect, and maintain tanks properly. API Standard 650, *Welded Steel Tanks for Oil Storage*, covers material design, fabrication, erection, and testing of tanks. API Standard 653, *Tank Inspection, Repair, Alteration and Reconstruction*, prescribes a tank inspection and repair program. Adherence to the construction, testing and maintenance procedures contained in API 650 and 653 precludes catastrophic failure of tanks containing hydrocarbons. Additionally, API Standard 2610, *Design, Construction, Operation, Maintenance and Inspection of Terminal and Tank Facilities*, provides a comprehensive guide to the best industry practices for terminal design, construction, inspection, maintenance, repair, and environmental protection.

- Prevent tank overfills. API Recommended Practice 2350, *Overfill Protection for Petroleum Storage Tanks,* provides guidance on the development of a tank overfill prevention program. This practice was revised in 1996.

In addition to API's standards, the survey data indicated that other measures are used to detect releases and protect the environment. Facilities utilize emergency response procedures and plans. Currently, facilities have Spill Prevention Control and Countermeasure (SPCC) plans and Facility Response Plans. These plans have been developed as part of the response and contingency planning necessary to quickly control and mitigate the effects associated with accidental releases.

EPA LINER STUDY

As required by the Oil Pollution Act of 1990, the Environmental Protection Agency (EPA) conducted a liner study evaluating the use of liners underneath tanks and in the diked area. After studying this issue for almost five years, EPA released its *Liner Study* in May 1996. The report made no recommendation with respect to liner usage; rather, EPA concluded that aboveground tank releases are best addressed through a voluntary program that relies on participant initiative.

With respect to diked-area liners, EPA's data implied that approximately 70 percent of reported oil discharges take place outside the diked or secondary containment area (EPA 1996).[1] The *Liner Study* states that EPA's on-scene coordinators "noted that most spills occur outside of the tank secondary containment areas, such as at the loading rack during product transfer operations. Such spills would not be addressed by liners in tank secondary containment areas." (EPA, 1996)[2]

Additionally, the EPA *Liner Study* gives information on capital costs to install diked-area liners. Average costs to install these liners or geomembranes (including polymeric sheets, bentonite or geo-composite mats, and polysulfide spray-on coatings) are shown in the table below:

Table 2 - Diked-Area Liner Installed Costs
Estimated in EPA Liner Study [3]

EPA Model Number	Facility Capacity (Thousands of Gallons)	Capital Costs (Thousands of Dollars) per Existing Facility
4	104	26
5	325	58
6	50,500	1,300

EPA's cost information appears compatible with industry data. Costs for installed liner systems average $4.50 per square foot. Using $4.50 per square foot and applying it to a lined area of 6.5 acres (the average size of lined diked areas for facilities involved in the survey), installed costs average $1.3 million. For specialized lining materials or for systems requiring major alterations to the existing tank farm, costs could range up to $8.50 per square foot of lined area. In addition to capital costs, operation and maintenance costs must be considered because of the tendency of the liner system to fail.

CONCLUSIONS

API's survey data indicate that the effectiveness of liners in protecting the environment is limited because of the liner's unreliability and the difficulty of inspecting or integrity testing the system. Further, the results of EPA's study and API's survey indicate that there are few releases from aboveground storage tanks that would be addressed by diked-area liners. Moreover, liner systems are expensive to install.

Thus, diked-area liners are not the most efficient means of protecting the environment given

1 *EPA Liner Study*, page 18.
2 *EPA Liner Study*, page 51.
3 *EPA Liner Study*, Information in the chart is based on data contained in exhibit 4-7, page 45 and exhibit 4-16 on page 63. Costs for retrofitting tanks with double bottoms have been removed.

- the tendency of liner systems to fail under day-to-day operating conditions,
- the limited benefit derived from the system in addressing oil discharges, and
- the high costs associated with installing, as well as operating, maintaining, and inspecting the liner system.

The survey data indicate that operators would prefer to use preventive measures rather than installing diked-area liners. Operators find that measures to prevent aboveground storage tank releases are more effective in protecting the environment and more cost-effective in the long run.

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API Publication No. 340, *Liquid Release Prevention and Detection Measures for Aboveground Storage Facilities.* 1997. American Petroleum Institute, Washington, D.C.

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API Std 2610, *Design, Construction, Operation, Maintenance, and Inspection of Terminal and Tank Facilities,* First Edition, 1994. American Petroleum Institute. Washington, D.C.

EPA Liner Study, Report to Congress, Section 4113(a) of the Oil Pollution Act of 1990, 1996. Environmental Protection Agency. Washington, D.C.

APPENDIX A
SURVEY QUESTIONNAIRE RESULTS

During phone interviews, SPEC Consulting developed Table A that compares the number of facilities that installed diked-area liners as a retrofit to an existing containment area versus the number of diked-area liners installed in new containment areas.

Table A-1 - Retrofit vs. New Facilities

Retrofit vs. New Facility	Number of Facilities Reporting	% of Facilities
Retrofit	29	91%
New	3	9%

The following data are presented on a question-by-question basis as asked in the survey questionnaire.

<u>Note</u> - The percentages were derived by dividing the number of facilities reporting by the total number of facilities surveyed (32). In some instances, a facility could have multiple responses to one question; therefore, the total number of facilities reporting on a given question could exceed the sample survey of 32 and the total percentages could exceed 100 percent.

<u>Question 1.</u> List products stored within lined containment areas.

Table A-2 - Products Stored

Products Stored	Number of Facilities Reporting*	% of Facilities
Gasoline	26	81%
Distillates	26	81%
Heavy products	0	0%
Aviation Fuels	3	9%
Ethanol	3	9%

* Many of the facilities stored multiple products within lined containment areas (i.e., gasoline, distillate and aviation fuels).

Question 2. Industry Sector.

Table A-3 - Sectors Reporting

Industry Sector	Number of Facilities Reporting*	% of Facilities
Refining	0	0%
Marketing	32	100%
Transportation	1	3%

Question 3A. Approximate area lined or covered by liner (sq. feet) ____ or (acres) ____.

Table A-4A - Area Covered

Area Covered (Acres)	Number of Facilities reporting	% of Facilities
<1 acres	4	13%
1 to 5 acres	16	50%
6 to 10 acres	8	25%
> 10 acres	4	13%

Question 3B. Does this area include the footprint of the tankage? (yes/no)

Table A-4B - Included Lined Area

Area Covered Includes Foot-Print of Tank	Number of Facilities reporting	% of Facilities
Yes	9	28%
No	23	72%

Question 4. Year liner was installed.

Table A-5 - Year of Liner Installation

Year Liner was Installed*	Number of Facilities reporting	% of Facilities
Pre 1989	1	3%
1989 to 1990	17	53%
1991 to 1992	9	28%
1993 to 1994	4	13%
1995 to present	1	3%

Question 5. Why was the liner installed?

Table A-6 - Reason for Liner Installation

Reason	Number of Facilities reporting	% of Facilities
Required by regulatory authority	27	84%
Company decision	5	16%

Question 6. Type of liner system installed.

Table A-7 - Type of Liner System Installed

Type of Liner	Number of Facilities reporting	% of Facilities
Coated Fabric	2	6%
Extruded Sheet	6	19%
Clay geo-composite	18	56%
Spray on Coating	4	13%
Native Clay Liner	1	3%
Improved Soil	1	3%
Concrete	2	6%
Asphalt	0	0%

<u>Question 7A.</u> Is liner system exposed or covered?

Table A-8A - Liner Cover Material

Liner Cover Material	Number of Facilities reporting	% of Facilities
Number of liners with a cover material	24	75%
Number of liners without a cover material	8	25%

<u>Question 7B.</u> How deep is the cover material?

Table A-8B - Depth of Cover Material

Depth of Cover Material	Number of Facilities reporting	% of Facilities
> 12"	2	8%
6" to 12"	22	92%
<6"	0	0%

<u>Question 8.</u> Why was this type of liner system selected?

Table A-9 - Reason for Selection

Reason for Selection	Number of Facilities reporting	% of Facilities
Cost	21	66%
Compatibility with stored product	20	63%
Ease of installation	20	63%
Ease of repair	18	56%
Expected long term performance	12	38%
Spills readily recoverable	9	28%
Allows accessibility	8	25%
Warranty of liner	4	13%
Ease of inspection	3	9%
Approved by state	2	6%
Unknown or no response	3	9%

Question 9. What was the design permeability of the diked area after installation of the liner?

Table A-10 - Liner Design Permeability

Design Permeability (cm/s)	Number of Facilities reporting	% of Facilities
$1x10^{-6}$	16	50%
$1x10^{-7}$	12	38%
$>1x10^{-7}$	1	3%
Unknown	3	9%

Question 10. Has the liner system met the design objectives? (yes/no)

Table A-11 - Meets Design Objectives

Design Objectives Met	Number of Facilities reporting	% of Facilities
Yes	0	0%
No	29	91%
Not sure	3 *	9%

* Respondents indicated that they had buried HDPE systems that had never been visually inspected.

Question 11. If the liner has NOT met the design objectives, please indicate the nature of the problem(s).

Table A-12 - Nature of Problems

Nature of Problem	Number of Facilities reporting	% of Facilities
Damage from vehicle traffic	22	69%
Failure of liner material (cuts, tears, rips)	21	66%
Tank chime area failure	18	56%
Subgrade or foundation material failures	17	53%
Weather or wildlife damage	4	13%
Groundwater or tidal damage	3	9%
Failure at seams	2	6%
Liner failure at penetrations	2	6%
Permeability failure	2	6%
Liner material degradation from sunlight	2	6%
Other problems	5	16%
No response	3	9%

Question 12. Has the liner system adversely affected the facility operation? (yes/no)

Table A-13 - Liner Impact on Facility Operation

Liner Adverse Impact on Facility	Number of Facilities reporting *	% of Facilities
Yes	28	90%
No	3	10%
No response	1	3%

* Two facilities that reported no impact were for new tank farm construction projects.

Question 13. If YES (to Question 12), please briefly indicate the operational problems that have occurred. (Check all that apply)

Table A-14 - Types of Operational Problems

Types of Operational Problems*	Number of Facilities reporting	% of Facilities
Increases storm water management	27	84%
Limits access to tank farm	21	66%
Creates maintenance hazard	3	9%
Creates tank buoyancy	2	6%
Creates fire hazard	1	3%
Other	3	9%

*Other issues reported above included: "having to more carefully plan work within the containment area," "problems with freezing dike drains" and "increased maintenance costs."

Question 14. If the liner system affected storm water management and drainage, please indicate the action taken. (Check all that apply)

Table A-15- Liner Effects on Storm Water Management

Impacts on Storm Water	Number of Facilities reporting *	% of Facilities
New storm water impoundment basin	18	56%
New oil/water separator	16	50%
New tank farm drainage	12	38%
Adjustment of equipment location & elevation	5	16%
Other	2	6%

* Facilities reported water accumulation at the tank chime area which would increase the rate of corrosion on the undertank side.

Question 15. Do you periodically evaluate and inspect the liner system performance? (yes/no)

Table A-16 - Inspection of Liner System

Periodic Inspection of Liner System	Number of Facilities reporting	% of Facilities
No	7	22%
Yes	25	78%

Question 16. If YES (to Question 15), please indicate the type of inspection that is conducted. (Check all that apply)

Table A-17 - Method of Periodic Inspection of Liner

Method of Periodic Inspection	Number of Facilities reporting	% of Facilities
Visual	11	34%
Groundwater Monitoring	1	3%
Leak Detection	0	0%
Probes	1	3%
Other	14	44%

Question 17. Has the liner system been subject to a release of petroleum? (yes/no)

Table A-18 - Has a Release Occurred?

Has liner experienced a release?	Number of Facilities reporting	% of Facilities
Yes	3	9%
No	29	91%

Question 18. If YES (to Question 17), what type of release was it? (Check all that apply)

Table A-19 - Type of Release Experienced

Type of release experienced*	Number of Facilities reporting
Overfill	1
Piping system	2
Fitting failure	0
Tank shell release	0
Other	0

* Most facilities did not experience a release.

Question 19. Did the liner prevent releases from reaching the soil or groundwater below the liner? (yes/no)

Table A-20 - Did Liner Prevent Release to Soil or Groundwater?

Did liner Prevent Release to Soil or Groundwater?*	Number of Facilities reporting
Yes	2
No	1

* Most facilities did not experience a release.

Question 20. How was this confirmed?

Table A-21 - Confirmation of Liner Performance

Method	Number of Facilities reporting
Removed Liner	2
Not Confirmed	1

Question 21. Would an alternative approach work better in protecting the environment? (yes/no)

Table A-22 - Better Approaches to Liners

Is there a better system than liners ?	Number of Facilities reporting
Yes	28
No	0
Not sure	4

Question 22. If YES (to Question 21), please indicate preferred alternatives. (Check all that apply)

Table A-23 - Alternate Approaches Available

Alternate Approaches to Liners	Number of Facilities reporting	% of Facilities
API Standards	23	72%
Emergency Response planning	20	63%
Leak Detection system	21	66%
Other	18	56%

APPENDIX B

LIQUID RELEASE PREVENTION AND DETECTION MEASURES FOR ABOVEGROUND STORAGE FACILITIES

EXECUTIVE SUMMARY

Preventing releases is an important aspect of day-to-day business for owners and operators of aboveground tank storage facilities. Over the years, operating practices have been developed and equipment has been designed to reduce the potential for releases and to protect the environment if a release occurs.

Data collected in a 1994 API survey of aboveground tank facilities indicated that the presence of groundwater contamination at aboveground storage tank facilities was mainly attributable to discontinued operating practices. Respondents reported significant reductions in releases because equipment, operating practices, and standards have improved. The 1994 survey focused on groundwater protection, but current practices at facilities address all facets of environmental protection. This report compiles information on current industry practices to prevent or detect releases, and to protect groundwater, surface water, and soil in the event of a liquid release.[4]

Specifically, the report addresses facility tanks, piping, loading/unloading areas, ancillary equipment, as well as facility operating systems -- or the human factor. For each of these components, the report provides:

- A summary of the potential causes of liquid petroleum releases;
- An overview of the procedures and equipment available to operators to prevent, detect or provide environmental protection from such releases; and
- The advantages and disadvantages of various control measures including relative costs, as well as maintenance and operating parameters.

Much of the information presented in the document is taken from API standards and research reports. Additionally, current industry practices and industry examples are included.

The report is not intended to provide requirements; rather it represents a compilation of the various methods that industry uses to prevent and detect releases. Effectively operating facilities and preventing releases involves the evaluation and use of a wide range of control measures.

[4]Air emissions are not addressed in this report.

Selection of appropriate measures must be made on a site-specific basis and tailored to meet the needs of each location.

The approach taken by the report is illustrated in Table ES-1, which gives an overview of types of releases that can occur at facilities and lists some of the available control measures. The table (which is not intended to be comprehensive) shows that multiple methods are available to address each type of release. The objective of this report is to facilitate selection of the appropriate measure and help the reader better understand the variety of methods that can be used to prevent releases or protect the environment if releases occur.

Table ES1 OVERVIEW OF LIQUID RELEASE CONTROL MEASURES

Source of Release	Type of Release	Examples of Control Measures[5]
Aboveground Storage Tanks	Tank overfill	• Written procedures • Operator training • Overfill protection systems
	Bottom leaks	• Inspection & maintenance program (API 653) • Cathodic protection (API 651) • Floor coatings and liners (API 650,651 & 652) • Release Prevention Barriers (API 650, Appx I)
	Tank shell / shell appurtenance release	• Inspection & maintenance program (API 653) • Secondary containment system • Use of API 650 design for new tanks
Piping Systems	Underground pressurized piping	• Cathodic protection (API 651) • Pipe coating (internal / external) • Proper piping system design (ASME / API) • Monitor pipe settlement • Inspection and maintenance program per API 2610/570
	Aboveground steel piping	• Visual inspection for defects • Pipe coating • Proper design (ASME / API) • Inspection and maintenance program per API 2610/570
	Underground gravity flow piping	• Pipe coating • Cathodic protection (API 651) • Special gaskets
Loading Areas	Loading/unloading	• Written procedures • Operator training • Monitor operations • Overfill protection systems • Pump emergency shutoff
Ancillary Equipment	Small equipment releases (e.g., pump, hose, flange leaks)	• Drip pans for equipment • Overpressure protection
Operating Systems	Human error	• Written procedures • Operator training • Monitor shifts & workloads

[5] The control measures are not listed in prioritized order and are not intended to apply universally.

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