

Assessment of Tankfield Dike Lining Materials and Methods

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FOREWORD

The American Petroleum Institute (API) commissioned the following assessment of currently available tankfield lining materials and methods for secondary containment within a diked area to meet the needs of its members operating in jurisdictions that require these liners.

API believes that a universal requirement for lining tankfields is an unnecessary expense and inefficient solution to concerns about possible environmental contamination from petroleum storage operations. The petroleum industry, operating through API, has developed and maintains engineering standards, recommended practices, inspection codes, and inspector certification programs that together provide petroleum storage management practices that minimize environmental risk from petroleum operations.

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EXECUTIVE SUMMARY

This report documents a study performed for the American Petroleum Institute (API) to provide an assessment of tankfield dike lining materials and methods for secondary containment within a diked area of aboveground petroleum storage facilities. For the purposes of this study, "secondary containment" refers to the diked area of a storage tank facility and does not include lining the area beneath a storage tank. The study includes a review of the current regulatory environment and a survey of candidate liner materials and installation methods.

The concept of secondary containment refers to the use of systems designed to contain overflow or spills of stored product for a period long enough so that removal and cleanup can take place with minimal release to the environment.

The construction and operation of aboveground storage tanks (ASTs) is covered by federal and state regulations. These include the federal Spill Prevention, Control and Countermeasures program under the Clean Water Act and state or local fire, safety and environmental codes. Ongoing activities under the Oil Pollution Act of 1990 (OPA) may lead to additional secondary containment regulations for ASTs. OPA's spill prevention and response provisions have not yet resulted in new regulatory requirements; however, final rules are expected this year. Also, OPA's liner study should be completed and sent to Congress this year. Liner requirements already exist in some states, and local rules may apply in a given location.

Industry practice, consistent with these regulatory requirements, has been to provide secondary containment systems, which include dikes, berms or retaining walls surrounding storage tanks. To be effective, the walls and floor of the containment area must be impervious to the product stored long enough to allow cleanup to take place in the event of a spill. One method of improving the effectiveness of diked areas in controlling spills or overflows is the use of liners to increase the imperviousness of the tankfield floor and walls or dikes. Liners may be constructed of either natural materials, such as low permeability clay, or synthetic flexible membrane liners (geomembranes).

As a result of this study, four types of liner systems were identified which have found application for secondary containment of petroleum in diked areas surrounding ASTs:

- (1) Supported coated fabrics or laminates, such as polymer films applied to a high-strength textile backing;
- (2) Unsupported, extruded plastic sheet geomembranes, such as high density polyethylene (HDPE);
- (3) Geosynthetic/clay composites (GCLs), which include a natural material such as bentonite affixed to a synthetic geotextile or plastic membrane backing; and
- (4) Spray-on coatings that are applied to a geotextile backing.

Low permeability to the contained substance is an important criterion for liner selection. Two modes of transport must be considered: liquid transport (hydraulic conductivity) and vapor transport (molecular diffusion or permeation). Natural materials, such as soils or clay, allow movement of liquid by hydraulic conductivity, driven by hydraulic head. However, most geomembranes are essentially impermeable to liquids. They are permeable to vapor to a degree that depends on the solubility of the liquid in the polymer, temperature, and the thickness of the membrane. It is important to understand the distinctions between these modes of mass transfer and how they relate to liner selection, testing and performance standards.

The fundamental differences among the four liner system types make installation-related factors key to liner selection. Installation is as important to liner integrity as the physical properties, impermeability, and chemical resistance of the base liner material. Considerations include seaming techniques and methods used to join liner panels to existing structures such as tank ringwalls, pipes, or other tankfield equipment. Liner cover, tankfield drainage, and cathodic protection can also be important.

The AST containment field provides a challenging installation problem because the number of sealing and liner connection points is usually large. The integrity of the liner system is dependent on attaining a liquid tight seal at all attachment points. Experience in the waste containment industry shows that liner system leakage can usually be attributed to sealing problems at points of attachment rather than permeation through liner panels. Successful installation depends on quality assurance and careful attention to detail during the construction process.

The long-term integrity of a liner installation is dependent on sub-base preparation/settlement, the physical strength of the liner itself, its resistance to the effects of aging or environmental degradation, and its resistance to chemical attack in the event of a spill. A liner may degrade in performance over time due either to accidental or intentional damage, or due to the effects of exposure to the elements. In considering liner selection and liner system design, it is important to understand the failure modes that can affect the different liner types.

Over the long term any secondary containment liner system will require some degree of maintenance, inspection and repair to maintain performance as installed. The maintenance program may be integrated into the overall tank maintenance procedures as required to maintain safety standards and sustain tank operations.

Section 1 INTRODUCTION

This report documents work performed for the American Petroleum Institute (API) by TRI/Environmental, Inc. TRI, an independent contractor, performed an assessment of tankfield dike lining materials and methods for secondary containment of aboveground petroleum storage facilities. The work was performed under authorization of a Letter of Agreement from API dated December 19, 1991. The technical information was reviewed by API's Storage Tank Task Force, as well as staff members from API's Manufacturing, Distribution and Marketing Department and the Health and Environmental Affairs Department. API's Office of General Counsel provided information on federal and selected state requirements for secondary containment at facilities discussed in the report.

The scope of this work included a survey of the current technology base for tankfield dike lining materials and installation methods as well as a review of the current regulatory environment and a survey of candidate materials and installation/construction methods. The scope of the study was limited to lining materials and methods applicable to the diked area outside the storage tank itself. The study does not cover liner installations for secondary containment underneath tanks.

Section 2 BACKGROUND

The petroleum industry uses aboveground storage tank (AST) facilities for storing large quantities of crude oil, petroleum products and additives. The construction and operation of such facilities is covered by federal and state regulations. These include the federal Clean Water Act's Spill Prevention, Control and Countermeasures program and requirements being implemented under the Oil Pollution Act of 1990, as well as state and local fire, safety and environmental codes. Several industry standards have been provided by groups such as the National Fire Protection Association, the Western Fire Chiefs Association, and API. These standards form the basis for most state and local fire or safety codes that govern AST facility construction and operation. The industry practice consistent with these codes and standards has been to provide spill containment systems, including dikes, berms or retaining walls surrounding storage tanks. Berms were originally installed for lateral control. In recent years, many companies have begun to install liners for tank bottoms.

Secondary containment systems are designed to contain overflow or spills of stored material for a long enough period to allow removal and cleanup without release of spilled material to the environment. The volume contained within the diked area must exceed the capacity of the largest tank located within the field. One method of improving the effectiveness of diked areas in preventing groundwater contamination is to use liners to increase the imperviousness of the tankfield floor and walls or dikes. Liners may be natural materials such as low permeability clay or geomembranes (synthetic flexible membrane liners).

AST facilities range from very large installations such as tank farms at pipeline or shipping terminals to individual retail and oil production sites that may consist of as few as one tank. AST facilities currently are subject to state and local regulations which vary from state to state, covering many aspects of construction, operation, and maintenance. In some areas of the country, natural or synthetic liner materials have been installed to meet new state or local requirements for tankfield secondary containment. Liners can be retrofitted to an existing facility or installed as part of new construction.

At present there is no universal regulatory requirement or industry standard that requires the use of liners in the secondary containment (diked) area. The following considerations are important to liner selection. First, a wide array of synthetic liners is available, many of which were developed for other applications such as waste containment. However, the industry lacks a consistent basis for comparison and selection, and must depend heavily on manufacturers' claims for performance and durability. Also, the installation of tankfield liners is a relatively recent practice, and long term experience with the use of liners in the tankfield is lacking.

The petroleum industry has been, and continues to be, affected in a significant way by new environmental, safety and health regulations. The Oil Pollution Act of 1990 was passed by Congress in the interest of protecting the environment from releases of hydrocarbon fuels from sources such as petroleum AST's. Under the Act's mandate, the U.S. Environmental Protection Agency (EPA) has initiated a study of available technology for secondary containment of petroleum fuels and other hydrocarbons stored in bulk in aboveground facilities.

The purpose of the API liner study documented in this report is to provide a reference source for selection criteria, technical standards, field and laboratory evaluation of liner performance, as well as installation considerations for synthetic liner systems.

Section 3

REVIEW OF THE REGULATORY ENVIRONMENT

This section describes existing and proposed federal and selected state requirements that address the use of liners to reduce the permeability of tankfield floors and dikes, and the construction and operation of AST facilities in general. The information is up to date through March 1993. However, there has been significant activity in both state and federal regulatory agencies to introduce new regulations for ASTs that may result in changes to the regulatory requirements presented below. In any event, the summary of requirements discussed below is presented solely to provide a context for evaluating the materials and methods assessed in this report. It is not intended to provide legal advice as to particular regulatory requirements.

FEDERAL RULES AND INITIATIVES

Federal requirements for ASTs include the Clean Water Act's Spill Prevention, Control and Countermeasures program and the Oil Pollution Act of 1990. The following sections describe current and proposed requirements.

Spill Prevention, Control and Countermeasures Program

The Spill Prevention, Control and Countermeasures (SPCC) regulations implement part of Section 311 of the Clean Water Act and apply to nontransportation-related facilities with aboveground oil storage capacity greater than 1,320 gallons, or greater than 660 gallons in a single aboveground tank. The existing SPCC rules appear in Title 40 Code of Federal Regulations (CFR) Part 112. These rules establish procedures, methods and requirements for equipment to prevent the discharge of oil into or upon "navigable waters" of the United States or adjoining shorelines. The term "navigable waters" has been interpreted very broadly, and includes wetlands, dry arroyos, and lakes under certain circumstances. See 40 CFR § 110 (definition of "navigable waters").

Proposed amendments to the SPCC Rules were introduced in the Federal Register on October 22, 1991 (56 FR 54612). The proposed rules evolved from recommendations of the interagency SPCC Task Force which had been assembled in response to a previous oil spill. The findings of the Task Force and a related GAO study formed the basis for the proposed changes.^{[1], [2]} The proposed rules would tighten recommendations provided in the original SPCC rules by making certain aspects of the SPCC rules mandatory. They comprise Phase One of the SPCC Task Force's recommendations. Phase Two (nontransportation-related onshore facility response plan regulations), proposed February 17, 1993, 58 FR 8824, would address the requirements of a properly designed spill contingency plan and would implement certain provisions of the Oil Pollution Act of 1990.

The following language appears in the Phase One proposed rule, 56 FR 54635, to be codified at 40 CFR § 112.7(c):

Appropriate containment and/or drainage control structures or equipment to prevent discharged oil from reaching a navigable water course shall be provided. The entire containment system, including walls and floor, shall be impervious to oil for 72 hours.... (Emphasis added.)

The most significant changes to the existing SPCC program, as they relate to secondary containment and liners, are that EPA has proposed substituting "shall" for "should," and has provided a time period (72 hours) to clarify the meaning of "impervious." In presenting the proposed rule, EPA stated that the specificity of the new 72-hour containment standard would provide the regulated community with greater clarification and flexibility than the phrase "sufficiently impervious" which appears in the current rule. The paragraph goes on to list prevention systems which may be used, including dikes, berms, retaining walls, and other kinds of structures to contain the product stored.

Oil Pollution Act of 1990

The Oil Pollution Act of 1990 (OPA) was enacted on August 18, 1990. Section 4113 requires that the President conduct a study to determine whether liners or other secondary means of containment should be used to prevent leaking or to aid in leak detection at onshore facilities used for the bulk storage of oil and located near navigable waterways. A one-year deadline was established for reporting the results of this study to Congress, and implementation of the report's recommendations was required six months after submission of that report.

Under the Act's mandate, EPA initiated a study of available technology for secondary containment of petroleum fuels and other hydrocarbons stored in bulk in aboveground facilities. The sponsoring office is EPA's Office of Emergency Response in Washington, D.C. As of this writing, the final report documenting the EPA's liner study is not yet available, although a preliminary draft has been reviewed.^[3] The study included a review of the regulatory environment, analysis of liner options, a cost/benefit analysis, and a discussion of regulatory options.

REQUIREMENTS FOR SECONDARY CONTAINMENT IN SELECTED STATES

Selected state secondary containment requirements for bulk storage of petroleum in ASTs are summarized below. Other regulatory requirements may be applicable in these states. This information is current as of March 1993. It is not comprehensive; some states may have requirements in addition to those described below. To assure compliance with applicable requirements for petroleum storage in ASTs, state and local laws and regulations should be reviewed in detail.