Flexible-Membrane Covers and Linings for Potable-Water Reservoirs

AWWA MANUAL M25

Third Edition

American Water Works Association

Contents

Chapter 1

Introduction

PURPOSE AND SCOPE

This manual is intended to serve as a technical reference guide in designing, installing, operating, and maintaining reservoirs using flexible-membrane materials for linings and floating covers. Source information was gathered by reviewing and collecting the experience of designers, manufacturers, and owners of flexible-membrane products that were introduced to the water industry in the early 1950s.

This manual is not intended to be a design handbook or the equivalent of an AWWA standard. Rather, it should serve as a technical reference document to be used in conjunction with AWWA D130, *Standard for Flexible-Membrane-Lining and Floating-Cover Materials for Potable Water Storage*, which was first approved for publication in January 1987.

Information in this manual may not apply to all types of installations or materials. In applying specific recommendations, the user must assume responsibility for accommodating a specific set of conditions.

DESCRIPTION OF FACILITIES

Flexible-membrane linings and floating covers can be incorporated into many types of water-storage facilities, both new construction and rehabilitated structures. Some typical examples of facilities include

- **An earthen reservoir for storage of untreated or raw water.** A flexible lining used in this type of installation is normally intended to minimize water losses due to seepage. In arid regions, a flexible-floating cover might be installed to reduce water loss due to evaporation, as well.

- **An earthen reservoir for storage of potable water.** Such a facility might be located at a water treatment plant or within a distribution system.

Normally, the structure would incorporate both lining and floating cover to reduce water losses and to protect the treated water from contamination.

- **A covered storage facility that has developed an excessive leakage condition.** This type of structure might be constructed of steel, concrete, or another material, or it might be asphalt-lined. Normally, a lining would be installed without a floating cover to reduce leakage and protect the stored water from outside contamination.

- **An uncovered storage facility requiring protection from contamination.** A flexible floating cover can quite often be used to meet these requirements. Many large, open reservoirs have been covered in this manner.

ADVANTAGES AND DISADVANTAGES

The principal advantages of flexible linings and floating covers are low capital cost, reduction of algal growth, reduction of chlorine demand, prevention of airborne and groundwater contamination, and prevention of evaporation and seepage losses.

The principal disadvantages of flexible linings and covers are susceptibility to damage by ice action and vandalism, shorter life expectancy than rigid cover installations, and the need for regularly scheduled maintenance to inspect the membrane and system integrity, remove surface water and debris, and make repairs.

PERMEATION

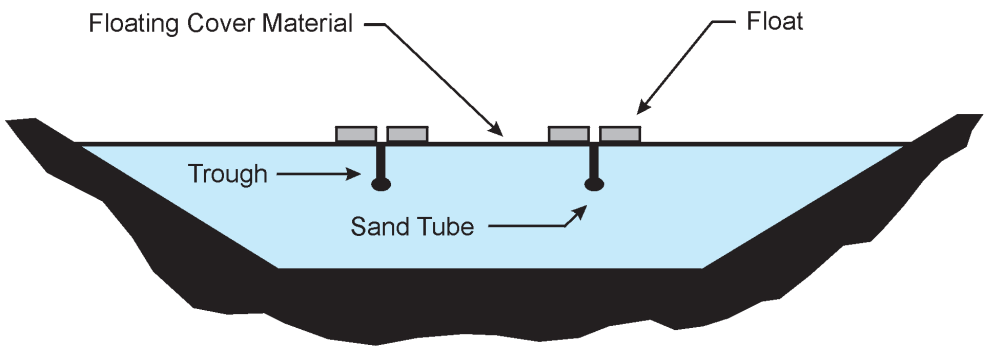
Selection of materials is critical for water-storage facilities and distribution piping in locations where the reservoir materials and/or pipe will likely be exposed to significant concentrations of pollutants composed of low-molecular-weight petroleum products or organic solvents and their vapors. Research has documented a potential for such compounds to permeate through plastic pipe materials such as polyethylene, polybutylene, polyvinyl chloride (PVC), and asbestos–cement and through elastomers such as those used in jointing gaskets and packing glands. If a reservoir must be located in, or a water pipe must pass through, an area subject to such contamination, consult with the manufacturer regarding permeation of pipe walls, jointing materials, reservoir membranes, and similar structures before selecting materials for use in that area.

DEFINITIONS

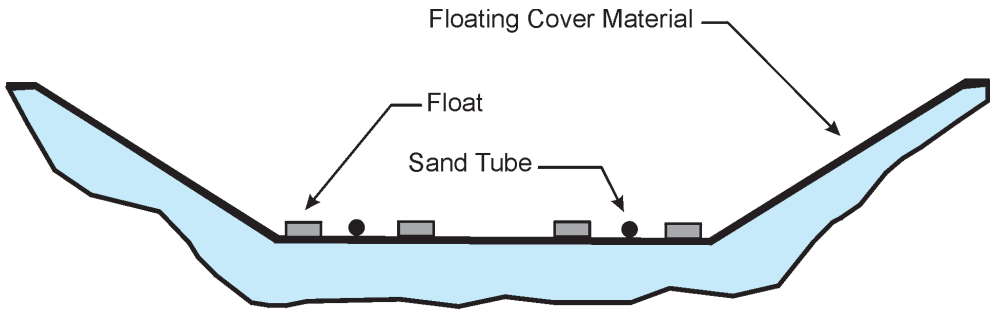
For the purpose of this manual, the following definitions apply:

Access features: Access hatches/pathways, perimeter access vaults, and perimeter canopies incorporated into a floating reservoir cover to allow access by personnel under the cover while it is floating or inflated.

Air vents: Vents provided only as required to release entrained air that enters the reservoir with the water and subsequently separates and bubbles to the surface beneath the floating cover. Vents are also used to prevent formation of vacuum in areas where water exits the reservoir (outlets, overflow drains, etc.). Vents can have a negative effect on wind resistance of floating reservoir covers, so their use should be minimized.



Schematic of full reservoir (not to scale)



Schematic of empty reservoir (not to scale)

Source: Metropolitan Water District of Southern California.

Figure 1-1 Cross sections of a typical weighted-sump floating-cover system, shown full and empty

Closed-cell float: (*See* Floats.)

Coating: A film built up through successive applications of an appropriate dispersion or solution system to achieve a specific dry-film thickness. Generally, coatings are applied to steel tanks for the purpose of protecting the steel against corrosion.

Cover: (*See* Flexible cover.)

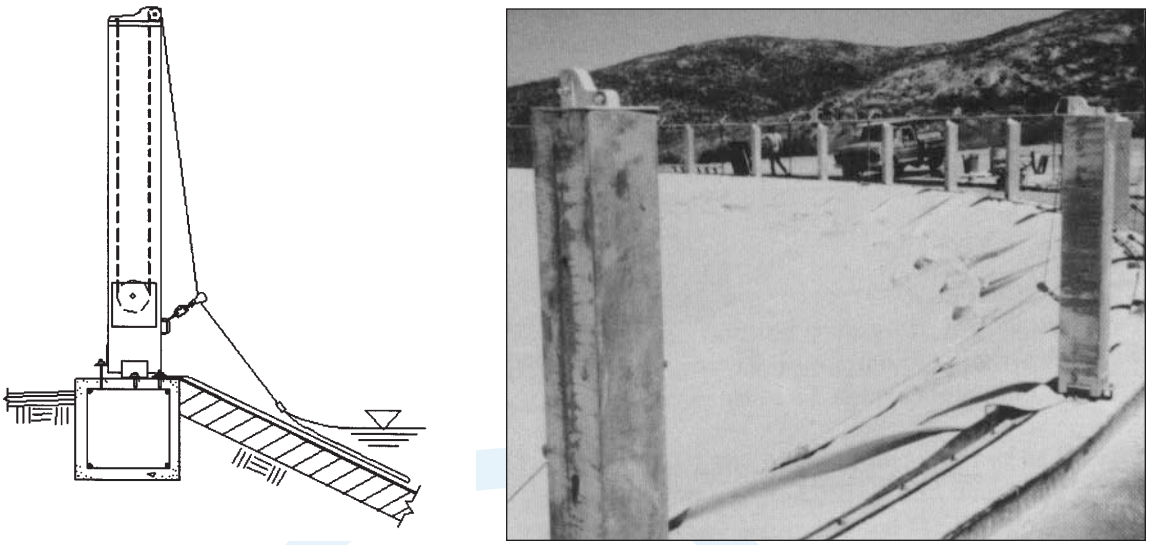
Cut-and-fill reservoir: A water-holding facility constructed by excavating a central portion and, normally, forming the excavated earth as fill material into an embankment that increases the capacity of the reservoir while avoiding costs of disposal for the excavated material.

Earthen reservoir: (*See* Cut-and-fill reservoir.)

Fabricator: The person, company, or organization that joins sheets of floating membrane material into large panels in a fabrication plant for delivery to the job site for installation.

Flexible baffles: Curtains of flexible membrane (usually the same material as the cover membrane) attached to the cover and extending vertically to the floor of the reservoir in geometrically prescribed locations. Flexible baffles direct the flow of water throughout the area of the reservoir to control the contact/residence time of disinfected water.

Flexible floating cover: A continuous, flexible, impervious, weather-resistant membrane material that floats on the surface of a water reservoir to function as a cover system. Three types of flexible floating covers are recognized: (1) a floating system, generally with a wind-stabilizing, closed-cell float grid system and weighted sump (*see* Figure 1-1); (2) a post-tensioned system, mechanically stabilized or tensioned (*see* Figure 1-2); (3) an inflated system (not discussed in this manual); and (4)



Source: C.W. Neal Corporation.

Figure 1-2 Mechanically tensioned floating cover

a nontensioned cover (not discussed in this manual, and no longer considered state-of-the-art technology).

Flexible membrane: Any of a number of continuous, flexible, impermeable membranes, usually ranging in thickness between 0.036 in. (0.91 mm) and 0.060 in. (1.52 mm), which may be fabricated into large panels for final assembly in the field. The membrane may be nonreinforced or scrim reinforced, depending on the physical requirements of the application. Three types of flexible membrane materials are generally seen: (1) plastic (thermoplastic), (2) cured elastomer, and (3) uncured elastomer (thermoplastic elastomer).

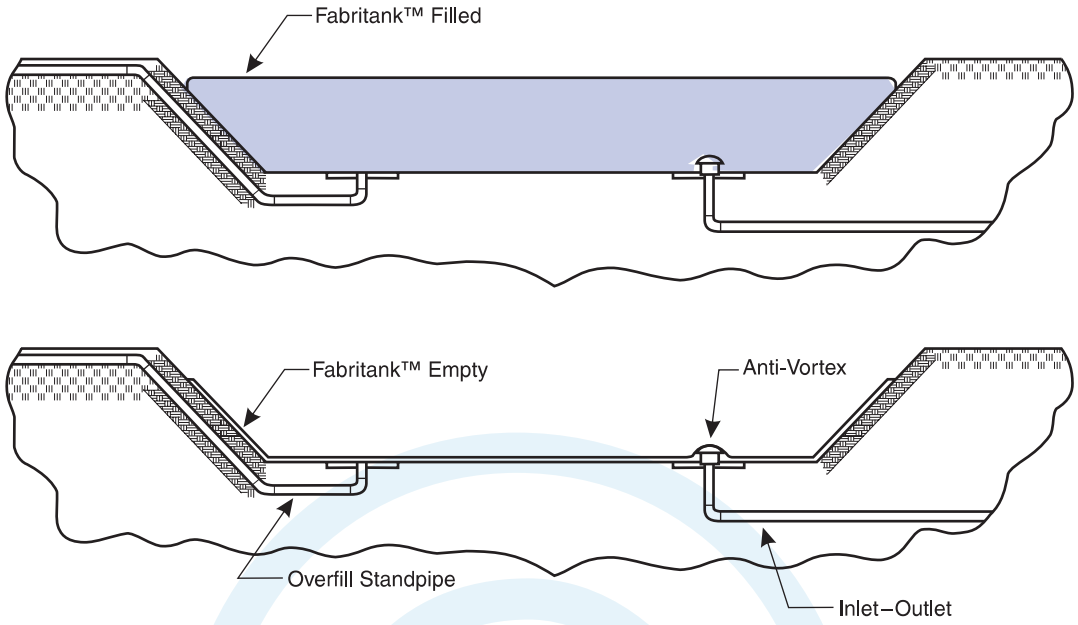
Flexible tank: A bag-like facility for holding liquid formed by sealing the edges of two appropriately shaped flexible membranes and provided with inlet, outlet, and overflow pipe connections. These installations, most commonly called "embankment-supported flexible tanks," are usually factory assembled, which precludes tank capacities larger than approximately 1 mil gal (3.785 ML). Tanks that meet the general guidelines of this manual and AWWA D130 could be considered suitable for installation, provided special design details and installation and construction methods are implemented as provided by the manufacturer. (*See* Figures 1-3 and 1-4.)

Floats: Closed-cell, semirigid foam members, usually encased in the same type of membrane material as the floating cover and permanently joined to it. A typical float cross section is 4 in. by 12 in. (100 mm by 300 mm); typical density is 2.2 pcf (35.2 g/L). Floats are usually required for wind stabilization, to facilitate rainwater removal, and as emergency buoyancy to prevent sinking of the cover in the event of a puncture.

Geotextile: A permeable synthetic fabric used to protect a flexible liner from damage due to rough or uneven surfaces and to promote venting of gases.

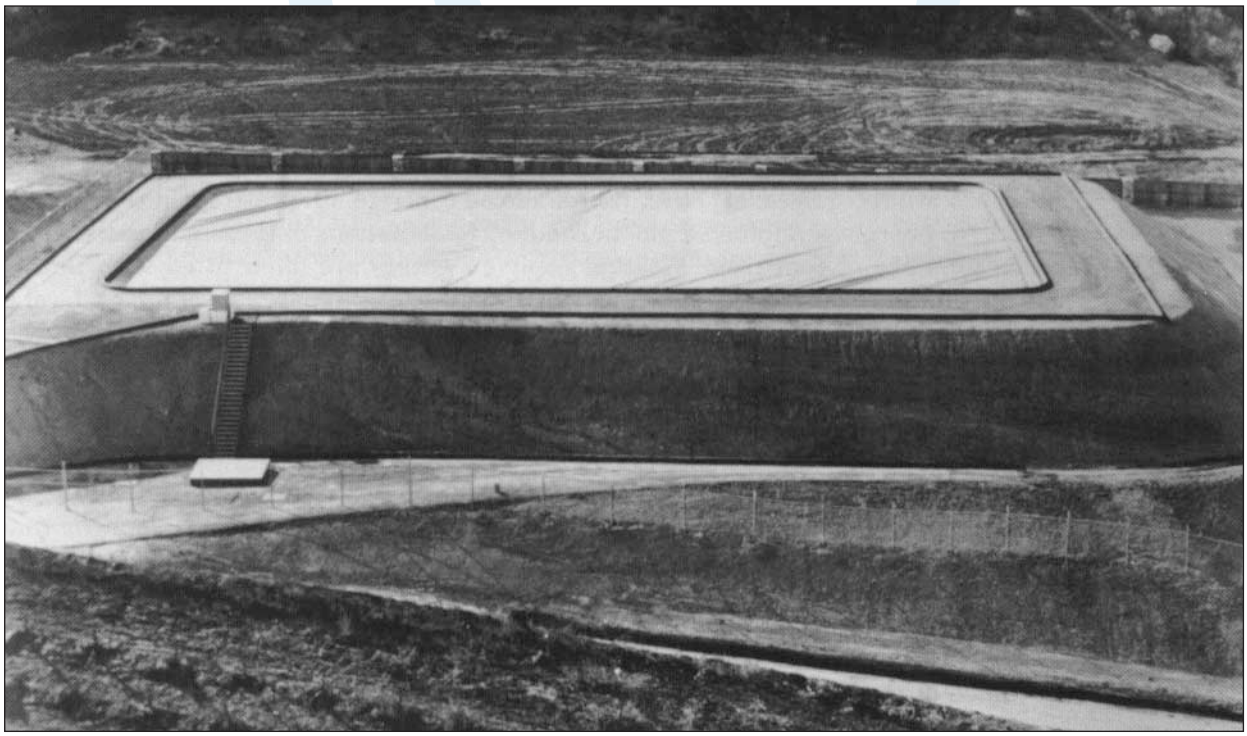
Inflation features: Specific design features to allow a floating reservoir cover to be conveniently, safely, and temporarily inflated and accessed for reservoir inspection, cleaning, and maintenance.

Installer (installing contractor): The person, company, or organization that installs the flexible-membrane liner or floating cover in the field.



Source: AMFUEL.

Figure 1-3 Cross sections of Fabritank™ cover system, shown full and empty



Source: AMFUEL.

Figure 1-4 Fabritank™ installation for a 1-mil-gal (3.785-ML) storage facility at San Jose, Calif.

Lining: A reservoir component designed to prevent leakage or infiltration of contaminants into the contained water. This component may be of flexible-membrane material, steel, reinforced concrete, asphalt lining, compacted earth, or a combination of these materials. Some designs integrate lining functions with the structural members of the reservoir, such as concrete walls and slabs, or asphalt linings.

Membrane: (*See* Flexible membrane.)

Membrane manufacturer: The person or organization that produces a flexible-membrane material.

Panel: The product of the assembly of two or more sections of flexible-membrane material cut and assembled by the fabricator using factory seaming techniques to form a portion of a membrane lining or floating cover ready for field assembly by the installer.

Purchaser: The person, company, or organization that purchases any materials or work to be performed.

Rainwater collection channel: A portion of a floating cover where reservoir geometry determines placement of excess material that distributes itself automatically and uniformly into a fold or sump configuration that collects and stores surface water before removal by pumping, siphoning, or gravity drainage.

Reinforcement: (*See* Scrim.)

Reservoir: A pond, lake, basin, or other water impoundment facility, either natural or constructed, that is used for storage, regulation, and control of water. (*See also* Tank.)

Scrim: Reinforcing material or fabric encapsulated within the flexible membrane.

Scrim edge: The edge of the reinforcing material encased in a membrane.

Substrate: The soil, concrete, asphalt, or other surface that supports a flexible membrane.

Sump: (*See* Rainwater collection channel.)

Supplier: (*See* Fabricator; Membrane manufacturer.)

Surface area: For both lining and floating cover systems, the value (expressed in square feet or square metres) obtained by adding (1) the area of the bottom, (2) the area of the sidewalls, and (3) the area of the anchor system.

Tank: A reservoir created in whole by constructing an engineered structure in which water or other liquids are stored. Ponds and lakes, naturally or artificially constructed, are not classified as tanks. (*See also* Reservoir.) Several general construction methods are seen: (1) steel, (2) reinforced concrete, (3) prestressed concrete, (4) wood, (5) fiberglass-reinforced plastic, and (6) combinations of these materials.

Tensioning features: Floating reservoir covers are often fitted with flexible weights or other devices for maintaining cover tension. These features impart a discrete, low-level tension to the cover membrane that stabilizes the cover system and provides for improved rainwater runoff and personnel access. (*See* Figure 1-2.)

SURVEY OF EXISTING FACILITIES

Surveys of existing storage facilities were conducted in 1979 and 1994 to develop technical information and performance records of various types of flexible-membrane materials and designs. A questionnaire was developed and sent to all known owners of tanks and reservoirs using flexible linings or covers. Results of the survey were incorporated into the content of this manual. Additional background information is available in published periodicals and technical journals. A limited bibliography is provided at the end of this manual.