

Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling

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Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling

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- PEI/RP1700, *Recommended Practices for the Closure of Underground Storage Tank and Shop-Fabricated Aboveground Storage Tank Systems*

FOREWORD

These *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling* have been prepared as an industry service by the Petroleum Equipment Institute. The text represents the consensus views of the PEI Aboveground Tank Installation Committee, comprised of the following members:

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This document supersedes and replaces the previous recommended practice entitled, *Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling*, PEI/RP200-13.

All questions and other communications relating to this document should be sent only to PEI Headquarters, addressed to the attention of the PEI Aboveground Tank Installation Committee.

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1. INTRODUCTION

1.1 Background. Historically, petroleum products at service stations and other motor vehicle fueling sites have been stored in underground tanks. In response to environmental requirements and emerging technology, however, aboveground tanks at motor vehicle fueling sites have become much more common.

1.2 Purpose. The purpose of this document is to provide a concise reference that describes recommended practices for the installation of aboveground storage systems at service stations, marinas and other motor vehicle fueling sites. The intent is to recommend practices that will minimize the possibility of aboveground storage system failure and reduce fire safety and environmental hazards, while avoiding practices that will needlessly increase installation costs.

This document is not meant to serve as a basic instruction manual. Because storage system installation is a specialized craft, it is assumed that those using these recommended practices will have a fundamental comprehension of essential procedures for pipe fitting, excavating, concrete placement, electrical installation and related construction techniques.

1.3 Scope. These recommended practices apply to aboveground, stationary, shop-fabricated tanks and associated piping and equipment intended to dispense gasoline, diesel and related fluids into motor vehicles at commercial and retail service stations and marinas. These recommended practices may be applied to horizontal and vertical tanks, single- and multi-walled tanks, as well as insulated, fire resistant and protected tanks. Tanks covered in these recommended practices are intended for the storage of liquid motor fuels at or near atmospheric pressure. Product piping associated with these tanks may be aboveground, underground or a combination of the two.

These recommended practices are not intended for terminals, oilfield production tanks, field-fabricated storage tanks, and storage systems for liquefied petroleum gases, liquefied natural gases or compressed natural gases.

For purposes of this document, a tank that is in a vault in which backfill is placed around the tank to any extent is considered an underground tank. Refer to PEI/RP100 for recommended practices concerning underground storage system installation.

These practices relate directly to installation procedures and are not intended to fully address the design,

operation, repair or maintenance of aboveground storage tank systems.

This document is not meant to provide interpretation of regulatory or legislative requirements related to tank storage, nor does it endorse or recommend particular materials, equipment, suppliers or manufacturers. The inclusion of procedures for the installation of equipment or devices is not meant to imply that such equipment or devices should always be used. Nothing in this document is intended to discourage the development and implementation of new methods and procedures.

1.4 Source. The practices outlined in this document represent a synthesis of recommendations published by various organizations, including the National Fire Protection Association (NFPA), International Code Council (ICC), American Petroleum Institute (API), Steel Tank Institute (STI), California Air Resources Board (CARB), U.S. Environmental Protection Agency (EPA), Underwriters Laboratories (UL) and NACE International (NACE).

In addition, some installation specifications and procedures have been derived from manufacturers of tanks, piping and related equipment. In instances when there were differences or omissions in material available from these sources, the Aboveground Tank Installation Committee of the Petroleum Equipment Institute has included consensus recommendations based on the practical experience of committee members with these systems.

1.5 Use of PEI/RP100. Aboveground tank installations may require some underground construction. For example, to achieve code separation distances between the tank and dispenser, it may be necessary to install piping belowground. The user of this document should refer to PEI/RP100, *Recommended Practices for Installation of Underground Liquid Storage Systems*, for additional guidance in the installation of underground components of aboveground storage systems.

1.6 Importance of Competent Installers. The installation of liquid motor fuel storage systems is a highly complex field and requires a wide range of construction knowledge and experience. In addition to proper design of an aboveground system, reliance on tank installers who possess both the experience and integrity to insist on doing the job right constitutes the greatest protection against ultimate tank system failure and liability exposure.

Written instructions alone will not convert an incompetent or under-supervised installer into a competent craftsman. The ability to recognize and react to unexpected

abnormal conditions encountered during a tank installation job requires experience and skill. Participation in appropriate training programs is essential to improving the skills of installers and the quality of installations.

1.7 Written Plans and Specifications. To properly solicit bids, obtain required permits and provide guidance for installers, facility owners who contemplate above-ground tank projects should provide a written scope of the proposed work, together with concise specifications and construction plans. These documents should adequately describe the property and indicate the size and location of system components. Clearly specify all material and equipment to be used as well as appropriate dimensions and construction details. Installation checklists may be developed from the plans and specifications. Checklists provide a convenient and effective tool for planning, implementing and documenting the required work.

1.8 Federal Regulations. Federal regulations require that the owner or operator of any aboveground petroleum storage facility where the aggregate storage capacity is more than 1,320 gallons, and where there is a reasonable expectation that product could be discharged to navigable waters, must prepare a Spill Prevention, Control and Countermeasure (SPCC) plan. The SPCC plan must be reviewed and certified. Proximity to storm sewers that drain to lakes, rivers and streams of any size may be sufficient to trigger the requirement for an

SPCC plan. Refer to Title 40, *Code of Federal Regulations*, Part 112, for a complete description of SPCC plan requirements.

1.9 Approval of Local Authorities. The recommended practices in this document are based largely on national codes and regulations. As with most fire safety and environmental regulations, state and local jurisdictions may have more stringent requirements than national codes with respect to licensing, spill containment, materials, equipment, capacity, setback requirements, drainage, separation from property lines and buildings, etc.

Contact the local authority having jurisdiction (AHJ) before plans are final or construction is initiated. Approvals may also be required from building code officials, environmental agencies, zoning boards and similar authorities.

Aboveground tank labeling and identification meeting the requirements of NFPA 704 should be displayed and located where visible, such as on the side of the tank or outside the dike. NFPA 704 defines the "fire diamond" used by emergency personnel to quickly and easily identify the risks posed by hazardous materials.

2. SITE PLANNING

2.1 Tank Location. Unlike underground tanks, aboveground tanks at a service station occupy a substantial portion of grade-level open space, thus restricting the use of the site for other activities. Therefore, establishing an optimum location for the tanks is of major importance. Regulations governing distances from public ways, property lines, dispensers, buildings and filling points must also be considered.

2.2 Tank Configurations. Aboveground tanks may be either vertical or horizontal and may be located at or near grade, elevated, or in vaults, above or below grade. (See Chapter 5.) Horizontal tanks may require substantially more yard area than is required for vertical tanks of the same capacity.

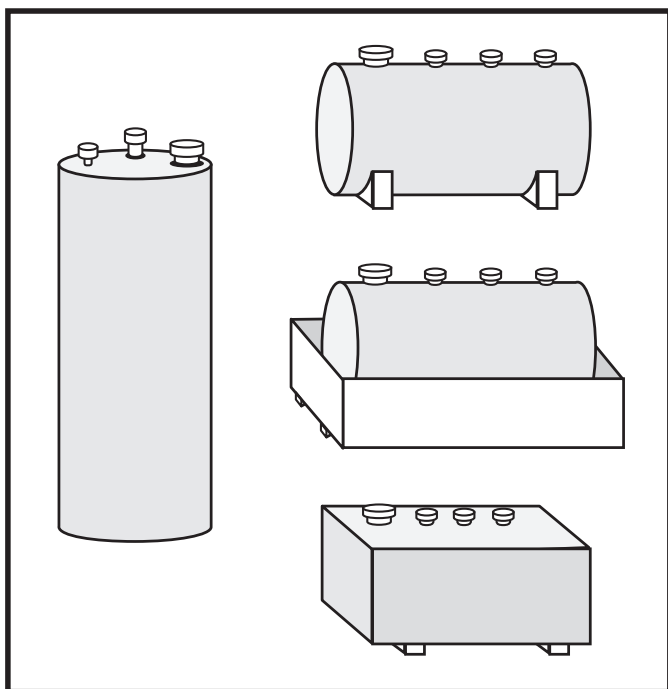


FIGURE 2-1. Typical Tank Profiles. Aboveground tanks may be vertical or horizontal, have a rectangular or cylindrical shape, and may include integral dikes.

2.3 Property Lines and Buildings. Aboveground tanks must be positioned to meet the setback and distance-from-buildings requirements of the local jurisdiction. Regulations may allow these distances to be reduced if tanks are insulated, fire protected, fire resistant (see Section 6.2.1.3) or vaulted. In many cases, these requirements are adapted from national consensus fire codes, such as National Fire Protection Association (NFPA) and International Code Council (ICC). Local codes may be more stringent, however, and should be consulted as

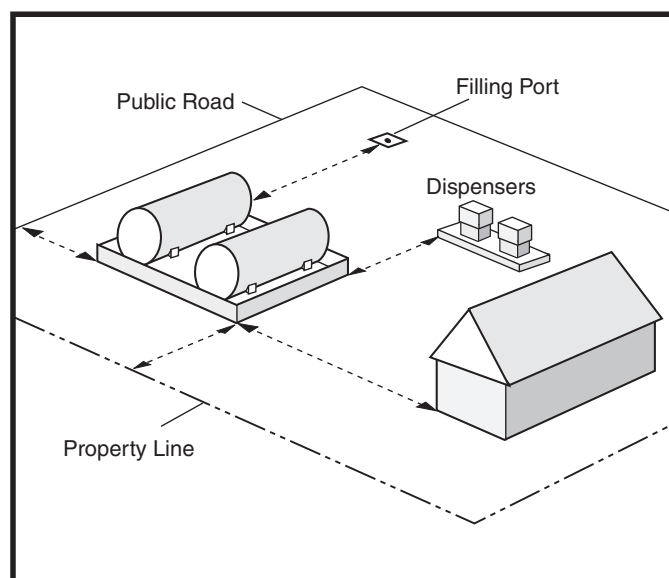


FIGURE 2-2. Spacing Constraints. Regulations dictate minimum separation distances between aboveground tanks and adjacent property lines, buildings, other tanks and dispensers.

part of the site planning process.

2.4 Tank Spacing Requirements. To allow passage between tanks for inspection, provide a minimum spacing equivalent to $1/6$ of the sum of the adjacent tank diameters, but not less than 3 feet. Space is also required between tanks and dike walls to allow visual inspection of tanks. Additional space may be required for dikes, vaults and security fencing, and for providing access to valves, piping, pumps and controls.

2.5 Bases and Foundations. Selection of a site and determination of the tank configuration can be significantly influenced by soil conditions. Installations in unstable soil will be more costly and may require extensive earth movement or additional foundations. (Refer to Chapter 3 for further discussion of this topic.)

2.6 Retail Service Stations. Codes may allow the use of aboveground tanks at retail service stations with certain individual and aggregate tank capacity restrictions. Tanks must typically be separated from dispenser islands, buildings, filling points and property lines by substantial distances. Separation distances may be reduced if protected tanks are used.

2.7 Commercial Fleet Fueling Facilities. Commercial fleet fueling facilities include those operated by truck lines, taxicab companies, car rental agencies, utilities, government agencies and similar users that are not accessible to the general public. Regulations typically

limit fueling to vehicles within the fleet, and limit the maximum individual tank capacity and the maximum aggregate capacity at the fleet fueling facility. Generally, no minimum separation is required between tanks and dispensers at such facilities. Distances to property lines and buildings may also be less restrictive than those for retail facilities. Determine tank locations according to traffic patterns, convenience and efficiency.

2.8 Marinas. The general requirements applicable to commercial and retail service stations also apply to the location of aboveground tanks at marinas. However, because marina tanks may be located long distances from pier-mounted dispensers, careful planning of piping is essential. It is also essential to accommodate changes in water levels and movement of docks by providing flexibility in the piping and electrical conduits. (See PEI/RP1000 for additional information.)

2.9 Product Deliveries. Except for below-grade, vaulted tanks, which can be filled by gravity, aboveground tanks are filled from pumping systems, located either on board the delivery transport or as a fixed component of the facility. Locate the fill connection point so that tanks are clearly visible during delivery. Ensure that spill-containment equipment installed at the fill connection point is capable of holding the maximum quantity of product contained in the delivery hose. Minimize the maneuvering required to position delivery vehicles adjacent to fill pipes. Codes may require a minimum distance

between the delivery vehicle and tank during tank filling operations.

2.10 Traffic Flow. Dispensing should be easily accessible and located where it will not interfere with other traffic flow. To ensure that vehicles keep clear of tanks, provide signs, arrows or marked corridor lanes for vehicle guidance. Where space is restricted, mount warning signs on fences, dikes or the tanks themselves. Installing mirrors at blind passageways may also be necessary.

2.11 SPCC Plan. If the facility will require a Spill Prevention, Control and Countermeasure (SPCC) plan, consult with the engineer responsible for the SPCC plan to discuss plan requirements. For example, an SPCC plan may require curbs, berms, or other means of spill control at the dispensing location or a spill retention area at the product delivery location. Security fencing may also be required. (See Section 2.13.)

2.12 Electronic Equipment. Automatic tank gauges, monitoring systems or automated access control systems may have special requirements limiting the distances between system components. Check the manufacturer's instructions prior to finalizing the site plan.

2.13 Physical Protection. Protect aboveground tanks from vehicle collision damage by installing bollards, concrete wheel stops, fencing or other barriers. Protect dispensing islands, platforms and any associated piping, valves or ancillary equipment from collision damage.

Codes or SPCC regulations may require that aboveground tanks be protected from vandalism by fencing and may specify fence location, construction and height. If the entire property is adequately fenced, fencing around the tanks may not be required.

2.14 Fire Protection. Risk of fire or explosion is greater at aboveground tank sites than at underground tank sites. Setback requirements are intended to provide room for fire fighters to work. Fire codes prescribe other fire protection requirements, including the type, number and location of extinguishers, along with prominently displayed instructions for their use. Codes may require that vaults containing tanks be equipped with a means for introducing a fire suppression agent. Additional fire protection, such as automatic suppression systems, automatic fire detection, emergency shutoff devices, fire alarm stations, and transmission of alarms to off-site locations, may be required by local authorities.

2.15 Utilities. Aboveground tanks should not be located above underground utilities or directly beneath

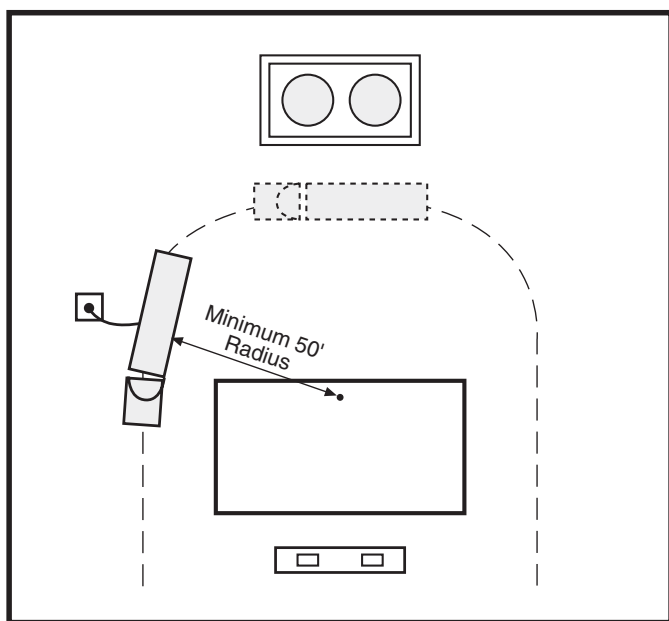


FIGURE 2-3. Traffic Flow. Access of fuel transports to the off-loading point is an important site planning consideration.

overhead power lines. Before construction starts to prevent accidental damage, determine the location of any underground or aboveground utilities by reviewing site plans, if available. In many locations, required one-call programs simplify the task of locating member underground utilities. Hiring a private utility locating service may be necessary to locate those utilities extending beyond the scope of the one-call service.

Be aware of overhead utilities that could impede construction or movement of tanks and equipment into the construction area.

2.16 Emergency Planning. In areas subject to flooding, make provisions to prevent tanks from floating. In areas subject to hurricanes or other significant storm events, make provisions to secure tanks against anticipated wind loading. In areas of seismic activity, check local building codes for seismic zone requirements. In all cases, consideration should be given to the containment of releases.

3. FOUNDATIONS, SUPPORT AND ANCHORAGE

3.1 General. Aboveground tanks built according to the standards described in Chapter 6 are designed for stationary use only. Foundations for aboveground tanks should evenly support the tank to prevent movement or uneven settling that could impose unacceptable stress on the tank. The foundation should be well drained to prevent the accumulation of water, which could accelerate corrosion. In areas subject to flooding or in cases where the accumulation of precipitation in a dike could produce uplift forces on the tank, provisions should be made for anchoring the tank. Consideration may be given to sloping the tank to facilitate water detection and removal.

3.2 Soil Analysis. Extensive site-specific soil analysis is generally not required for shop-built aboveground tanks unless the soil is unstable or unless the tanks are located in a flood plain. In these cases, an assessment of the stability of the soil is recommended to reduce the possibility of future structural failure. A competent engineer may be engaged to conduct a soil-boring analysis and to recommend a suitable foundation design. Soil data may also be available from local engineers, contractors, facility owners and public works departments. Where tanks will be installed in contact with the soil, the corrosive potential of the soil should be determined.

3.3 Tank Foundation Design. The primary criterion for tank foundation design is the allowable bearing pressure of the soil. This ranges from 1,000 pounds per square foot (psf) for soft clay to more than 4,000 pounds psf for coarse, compacted gravel.

To place these soil-bearing pressure numbers in context, consider that a single-walled, 12,000 gallon vertical tank, 8 feet in diameter and full of gasoline (specific gravity of 0.75) exerts a downward pressure of approximately 2,000 pounds psf on its foundation and, in turn, on the subsoil. The load per square foot on the soil from horizontal tanks depends on the number of saddles and the size of the footings. An insulated or fire-protected tank may weigh considerably more and may impose greater loads on the underlying soil than a single-walled aboveground storage tank.

Where investigation and analysis indicate that the soil will not safely support the weight of the fully loaded tank, one or more of the following measures should be considered:

- replacing the subsoil;

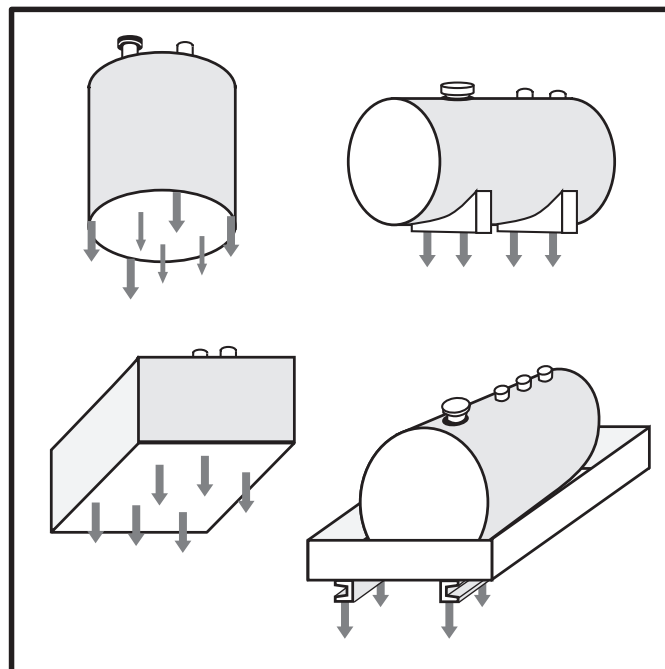


FIGURE 3-1. Load Distribution. Load distribution varies greatly among different aboveground tank designs and must be considered when designing tank foundations.

- placing a reinforced concrete pad on pilings;
- placing a reinforced concrete slab on grade;
- stabilizing fine soils with a geotextile; or
- stabilizing the soil with a compacted mixture of hydrated lime or dry cement and pulverized soil.

Only a qualified individual should determine the method to be used.

3.4 Excavation. At a minimum, remove vegetation, top soil and any other unsuitable materials. Scarify the subsoil to provide a bond with the foundation base course. Excavate to a depth sufficient to place and compact the materials forming the base course for the tank foundation. Replace any soft zones with suitable materials to ensure the full and even support of the tanks.

Excess or unsuitable excavated materials that cannot be transported immediately from the area or disposed of on-site should be safely stockpiled away from the work area. Handle and dispose of hazardous waste or contaminated soil in accordance with appropriate environmental and fire safety regulations. Place barricades as needed to protect the public and installation personnel, and to prevent damage to the work area from vehicles and construction equipment.

3.5 Base Course. The base course material should be crushed stone or a similar non-cohesive material that is free of organic matter and that will compact adequately. Place the base course material in lifts that are no more than 6 inches thick and compact thoroughly. Correct depressions and poorly compacted areas.

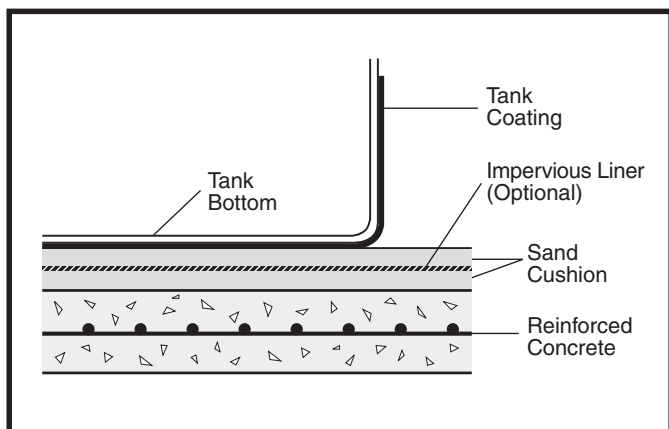


FIGURE 3-2. Vertical Tank Base Section. A sand cushion, which may include an impervious liner for release detection, is typically placed between a concrete foundation slab and the tank bottom. The tank bottom must also be protected against corrosion. (See Chapter 11.)

3.6 Vertical Tank Bases. A suitable foundation for vertical tanks can be constructed with a finished course of clean, compacted sand, gravel or crushed rock that is placed over the base course. The base and finish courses should extend at least 12 inches beyond the perimeter of the tank. The finish course should be level. For larger tanks, measure each quadrant of the base for uniformity of elevation using a builder's level. Protect the finish course material from migration or wash out. For smaller tanks or tanks with double bottoms that can be monitored, a properly engineered concrete pad may also be used as a base. (See Section 3.8.) To provide for drainage and settlement, the surface on which the tank bottom rests should be at least 6 inches above the surrounding ground surface.

3.7 Horizontal Tank Saddles. Saddle supports for horizontal tanks may be constructed of steel or reinforced concrete, and must be installed on a firm and stable foundation. The size of footings for saddles depends on the characteristics of the subsoil, the stability of the base course and the number of saddles. The location and number of supports necessary to prevent excessive stress on the tank should be determined by the manufacturer. Factory-fabricated steel saddles may be either an integral part of the tank construction or a separate component. Exercise care to ensure that the footings of horizontal tank saddles are level. After setting, check all tanks for level and correct any residual tilt with full-width shims.

WARNING: Fire codes require that tank saddles higher than 12 inches above the foundation have a minimum fire rating of 2 hours and be constructed of protected steel, masonry or reinforced concrete.

3.7.1 Electrical Isolation of Tank Saddles. To protect the tank coating, which provides protection against corrosion, carefully isolate the saddles from the tank shell through the use of a dielectric

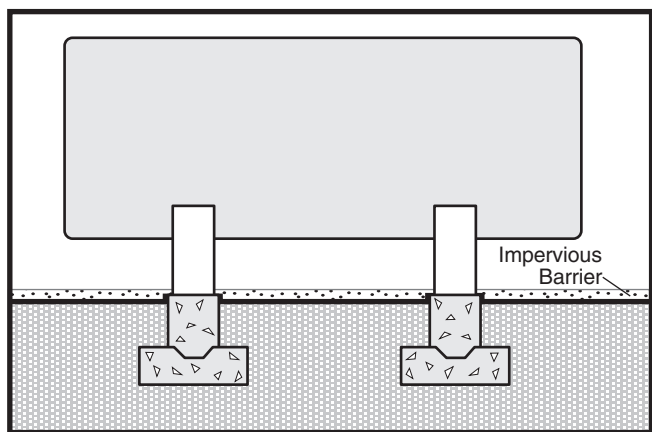


FIGURE 3-3. Horizontal Tank Support. Horizontal tanks may be supported on saddles set on concrete footings. Design of the footings must consider the bearing loads and the subsoil characteristics. The joint between footings and any impervious barrier must be liquid tight.

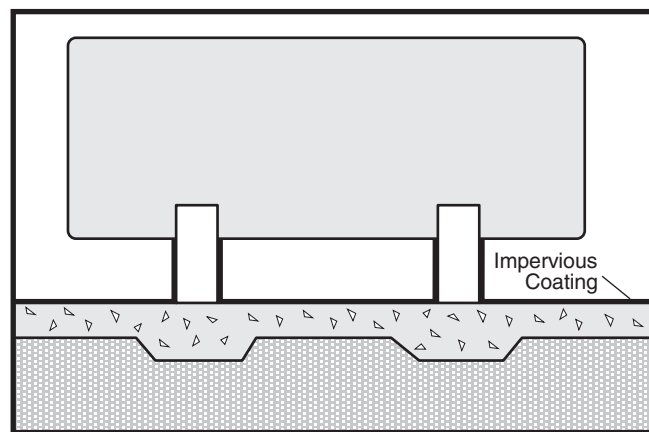


FIGURE 3-4. Horizontal Tank Support. Support for tank saddles may also be provided by a properly designed concrete dike floor.

material. Information on appropriate isolation materials is available from the tank manufacturer. Roofing felt or concrete expansion joint materials are not acceptable. Electrical isolation is not necessary if the saddles are seal-welded to the tank.

3.8 Reinforced Concrete Tank Slabs. Reinforced concrete slabs may be used to support vertical tanks or used together with tank saddles to support horizontal tanks. Typically, concrete slabs are 6 to 12 inches thick and constructed to meet a 28-day, minimum 3,000 pounds per square inch (psi) compressive strength requirement. The amount of reinforcing that may be necessary, as well as the possible need for a moisture barrier, is dictated by the characteristics of the subsoil and the stability of the base course. Only persons with training and experience in the field of concrete design should be allowed to specify the construction details of concrete tank foundations.

3.9 Anchoring. Protect tanks located in areas subject to flooding from flotation. Even in non-flood areas, the accumulation of rainwater within a dike may be sufficient to cause movement of the tank. The tank should be secured to a foundation or restraining pad with sufficient weight to prevent flotation of an empty tank at the maximum anticipated water level. The amount of weight required is determined by multiplying the capacity of the tank, below maximum anticipated water level, by the weight of water (8.3 pounds per gallon), and subtracting the weight of the tank, equipment and attached supports. When making this calculation, remember to use submerged weight for those components that will be below the maximum water level. Responsibility for the design of the concrete pad beneath the tank and determination of the method of anchoring should be assigned to a qualified individual.

4. DIKES

4.1 Purpose. Dikes around aboveground tanks and associated piping are designed to contain product spills and releases from tanks, piping and associated equipment within the dike. Releases from aboveground storage systems can result from loose fittings, corrosion, thermal stress, structural failure or collision. Spills may occur when delivery hoses are disconnected, when tanks are overfilled or when vandalism occurs. Major storage system failures may result from intense heat from a fire, or from stress created by seismic or hurricane forces. Dikes should contain releases and spills, and prevent product from entering the ground.

4.1.1 Alternatives to Diking. Some codes allow the use of secondary containment tanks in lieu of dikes when certain other requirements are met. These requirements can include the use of overfill prevention devices, overfill alarms, fill gauges, anti-siphon devices and secondary containment interstitial monitoring. Codes may restrict such installations to certain capacities, depending on whether the product stored is a Class I or Class II liquid. Refer to national codes and local jurisdictional requirements for further information.

4.2 Dike Capacity. A dike must be able to hold the greatest volume of product that may be released by the largest tank within the dike. Additional dike capacity may be required to allow for rainwater accumulation in the dike or to provide an additional margin of safety. Where the diked area encloses more than one tank, the volume occupied by the additional tank(s) in the dike is not available to contain a release from the largest tank. Because of this, the volume occupied by the portion of the smaller tank(s) that is lower than the dike wall must be taken into account when determining dike capacity. A detailed explanation of how to calculate dike capacity is presented in Appendix A.

4.3 Dike Construction. Dike walls may be constructed of earth, steel, concrete or solid masonry. Dike walls should be liquid tight, impervious to the liquid stored and capable of withstanding the hydrostatic pressure of the contained liquid when full. Earthen dike walls that are 3 feet or more in height should have a flat-top surface that is at least 2 feet wide. The slope of an earthen dike wall should not exceed the angle of repose of the material used to construct the dike. Steel dikes may be an integral part of the tank.

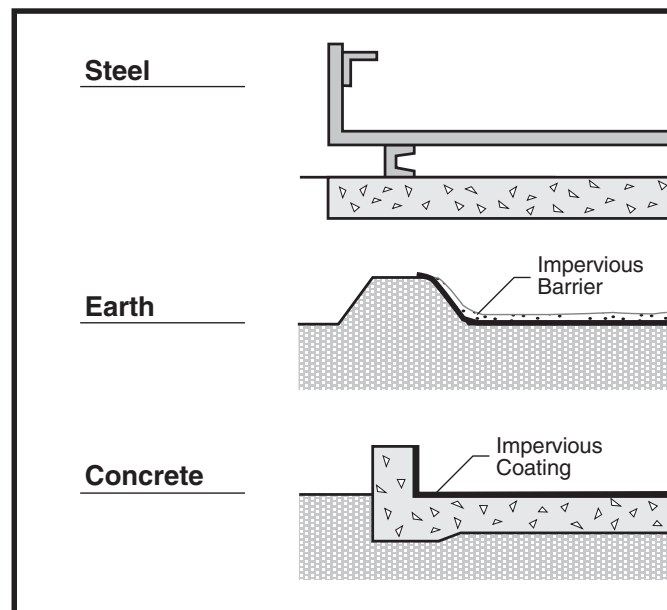


FIGURE 4-1. Typical Dike Sections. Dikes may be constructed of steel, earth or concrete.

4.4 Impervious Barrier. The walls and bottom of a diked area may consist of specially formulated and well-compacted clay, solid pavement, coatings or impervious membrane liners. Concrete, made impervious, may be used. Materials should be specifically designed and tested to ensure compliance with environmental standards. Install coatings and liners in accordance with the manufacturer's instructions.

Before covering an impervious barrier, inspect it to determine whether any damage has occurred, paying special attention to seams. Liner manufacturers provide instructions for proper testing of their products, along with instructions for making any last-minute repairs. Replace the liner or repair any damage in accordance with the manufacturer's instructions. This work should be performed only by qualified personnel who are trained by the manufacturer.

4.5 Dike Penetrations. Piping and conduit should pass over the top of the dike. Where penetration of the dike wall or floor is absolutely unavoidable, the penetration should be sleeved and sealed so that it is liquid tight.

4.6 Access. Provide access to the tanks, valves and piping within the diked area. Safety regulations may require fixed stairs and handrails at the access points. To permit access for fire fighting and to protect adjacent buildings, ensure that the outside base of the dike is no closer than 10 feet from any property line that is, or can be, built upon.

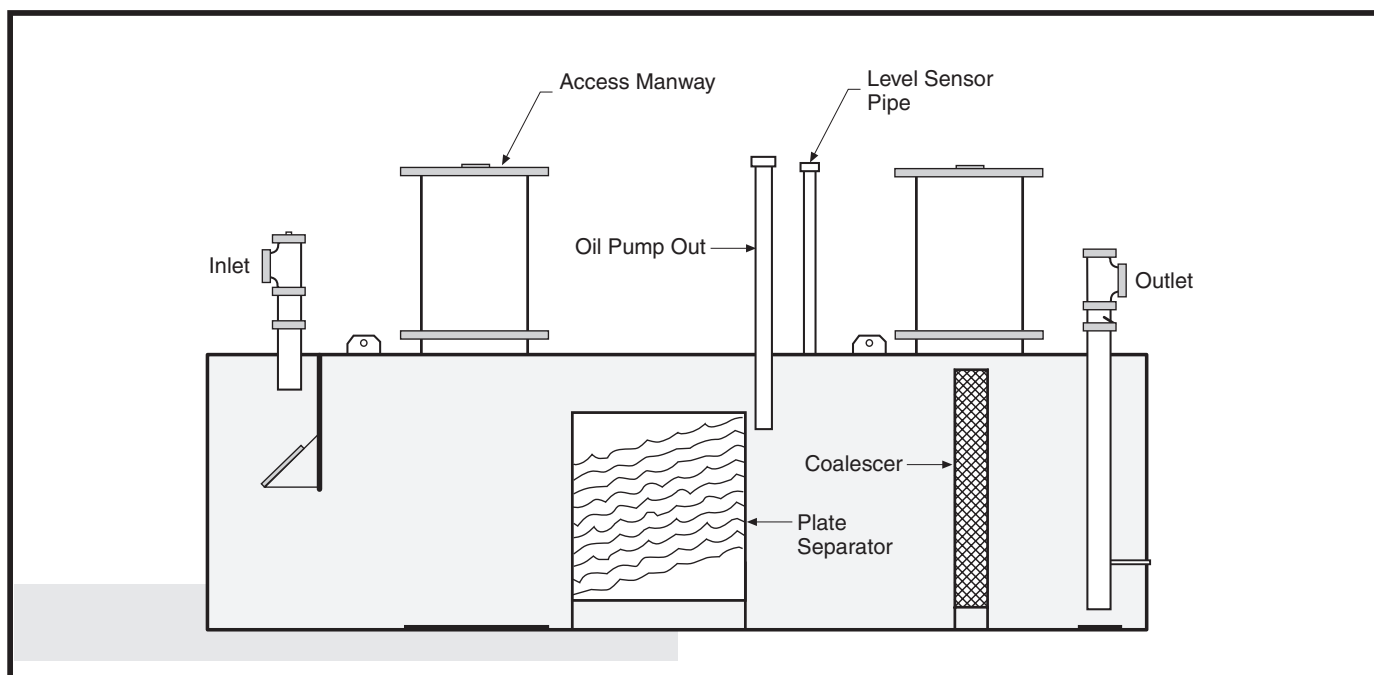


FIGURE 4-2. Oil/Water Separator – Underground Single-Walled Unit. Oil/water separators are often used to remove oil from water that is being drained from contained areas, such as dikes, tank filling and product dispensing locations.

4.7 Drainage Control. Control the drainage of liquids from diked areas to prevent the contamination of natural water courses, public sewers or utilities. Locate drainage control points outside the diked area, protect them from physical damage and be sure that they are accessible under fire conditions. Grade the area within the dike away from the tank at a minimum slope of 1 inch per 8 linear feet (1 percent). Drain the interior of the dike to a collection sump, where storm water or other contained liquids can be siphoned or pumped over the dike wall. Liquid disposal is regulated by fire safety and environmental agencies.

WARNING: Retention of water within a diked area reduces the dike capacity and may cause unanchored tanks to float. (See Section 3.9.)

4.8 Oil/Water Separator. If storm water is contaminated by petroleum, free product can be skimmed from the collection sump and disposed of as waste or processed in an oil/water separator. Oil/water separators rely on gravity to separate lighter-than-water oil globules from water. The performance of the separator varies with the characteristics of the liquids and the design of the separator. The effluent from the separator is often directed to a sewer. Consult the authority having jurisdiction to determine local discharge requirements.