

# Installation of Underground Petroleum Storage Systems

**Marketing Department**

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## FOREWORD

The prevention and detection of product releases from underground petroleum storage and handling systems are important to both industry and the public. In preparing this recommended practice, careful consideration was given to the following:

- a. Promoting safety.
- b. Protecting human health and the environment.
- c. Preventing storage-system leaks and failures.
- d. Detecting petroleum product releases.
- e. Protecting product quality.
- f. Minimizing maintenance.
- g. Minimizing installation costs.

Every effort was made to ensure consistency with the applicable sections of NFPA 30 and NFPA 30A. In addition, consistency was maintained with the provisions of NFPA 329 for the testing of underground storage systems. (See 1.4 in text for further reference information.) Standards that apply to specific materials and equipment are referenced as necessary in text.

This edition of Recommended Practice 1615 supersedes API Publication 1615, *Installation of Underground Petroleum Storage Systems* (November 1979) in its entirety.

At the time this recommended practice was written, legislation and regulations related to the installation, operation, maintenance, abandonment, and removal of underground petroleum storage systems were under development at the federal, state, and municipal levels. The appropriate government agencies should therefore be consulted about regulations that apply to the area of installation before any action suggested in this recommended practice is taken.

Petroleum equipment installations are unique in the construction industry, and contractors selected for work should be experienced in this area. In highly technical areas, such as vapor recovery, cathodic protection, and underground-tank flotation calculations, professional assistance should be obtained. Such assistance may be available from manufacturers of petroleum equipment, installers of petroleum equipment, engineers, or petroleum suppliers.

For further safety information, see API Publications 1628, 2005, 2015, and 2217. (See 1.4 in text for further reference information.)

Suggested revisions are invited and should be submitted to the director of the Marketing Department, American Petroleum Institute, 1220 L Street, N.W., Washington, D.C. 20005.

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# Installation of Underground Petroleum Storage Systems

## SECTION 1—INTRODUCTION

### 1.1 General

Petroleum product releases from underground storage systems are a problem that can affect safety, health, and the environment. Releases may be caused by improper installation and maintenance of a storage system. Success in preventing releases depends on a number of factors, including the following:

- a. Sound design of installations.
- b. Proper selection of materials for specific locations.
- c. Installation in accordance with sound engineering specifications, practices, and manufacturers' instructions.
- d. Capable, adequate supervision and quality assurance during installation.
- e. Thorough testing at appropriate stages during installation and operation.
- f. Appropriate monitoring and maintenance programs.

### 1.2 Purpose and Scope

**1.2.1** This recommended practice is a guide to procedures and equipment that should be used for the installation of underground petroleum storage systems. It is intended for use by architects, engineers, marketers, jobbers, and contractors.

**1.2.2** The primary application of this recommended practice is in connection with the underground storage of bulk petroleum products and used oil at retail and commercial facilities. It is not intended to cover specialized installations, such as fuel storage systems at marinas and airports, heating oil storage systems (either residential or bulk), or systems to be installed inside buildings. This recommended practice does not apply to the installation of in-ground and aboveground bulk storage systems. The reader is referred to the following standards for information on specialized storage systems:

- a. For marinas, NFPA 30A.
- b. For residential storage of heating oil, NFPA 31.
- c. For bulk storage of heating oil, API Standard 650.
- d. For storage inside buildings, NFPA 30.
- e. For aboveground tankage, NFPA 30 and API Standard 650.

**1.2.3** This recommended practice applies to underground storage tank systems (see 1.3.38) that are used to store petroleum products at retail and commercial facilities. The stored products include gasoline, diesel fuel, kerosene, lubricating oils, used oil, and certain alcohol/gasoline blends. (For information on alcohol/gasoline blends, see API Recommended Practices 1626 and 1627.) This recommended practice may not apply to other petroleum products. The product manufacturer and the authority having jurisdiction (see 1.3.1) should be consulted with regard to the proper storage of other products. (For recommendations on system management, see API Recommended Practice 1635.)

**1.2.4** Anyone preparing to design or install an underground storage tank system in a U.S. Environmental Protection Agency Air Quality Control Region should investigate the federal, state, and local requirements and current methods of compliance for vapor recovery in that region. Vapor recovery (see 1.3.40) is covered in greater detail in Section 12 of this document. For more information on the design and installation of vapor recovery systems, see NFPA 30A.

### 1.3 Definitions

Terms used in this recommended practice are defined in 1.3.1 through 1.3.43.

**1.3.1** The *authority having jurisdiction* refers to the one or more federal, state, or local government agencies or individuals responsible for approving equipment, installations, and procedures associated with underground storage tank systems.

**1.3.2** An *automatic tank gauging system* is an automated device used to measure the level of petroleum product in an underground storage tank and/or to measure the rate of change in the level of petroleum product over a period of time.

**1.3.3** *Cathodic protection* is a process that prevents or inhibits corrosion of steel surfaces by managing or redirecting natural or man-made underground electrical currents.

- 1.3.4** *Corrective action* is action taken to identify, report, contain, treat, and/or remove petroleum hydrocarbons that have been released underground.
- 1.3.5** A *double-wall pipe* is a form of secondary containment in which a pipe is constructed with two shells, or walls, with an interstice between to contain a release from the primary pipe.
- 1.3.6** A *double-wall tank* is a form of secondary containment in which a storage tank is constructed with two shells, or walls, with an interstice between to contain a release from the primary tank.
- 1.3.7** *Equivalent* means "similar" or "equal," as the term pertains to effectiveness, sensitivity, or accuracy.
- 1.3.8** A *flexible joint* is a joint in the piping system that allows differential movement of the piping system without imposing undue stress or physical damage on the system.
- 1.3.9** *Generally accepted engineering practices* are techniques or methods that are commonly applied by qualified engineers.
- 1.3.10** An *impermeable barrier* is a natural or man-made barrier that impedes the vertical migration of released product.
- 1.3.11** An *impervious liner* is a form of secondary containment in which a natural or synthetic material prevents transmission of petroleum product. An impervious liner is usually placed in the ground around a tank system to contain released petroleum product and provide secondary containment.
- 1.3.12** *Impervious soil treatment* refers to the treatment of natural soils with a material or materials that decrease their permeability, causing them to act as a barrier that prevents the transmission of released petroleum product.
- 1.3.13** A *leak* is a perforation, hole, crack, or other opening in an underground storage tank system that will allow product to escape the system or its secondary containment.
- 1.3.14** A *limited-access manhole* is a manhole used with an observation well to which entry is restricted by requiring the use of a special tool to open the manhole.
- 1.3.15** *Monitoring* refers to the periodic checking or testing of an underground storage tank system's equipment, detection devices, and monitoring or observation wells for evidence of released petroleum product or for assistance in verifying the integrity of the system.
- 1.3.16** A *monitoring well* is a cased in-ground well that (a) is located outside the excavation of an underground storage tank system, (b) is in contact with groundwater, and (c) is designed to assist in detecting releases of liquid product from an underground storage tank system.
- 1.3.17** A *municipal water well* is a well that is operated by a public agency and provides the public with potable water.
- 1.3.18** A *noncorrosive material* is a material that resists all forms of electrochemical corrosion.
- 1.3.19** An *observation well* is a cased well within the tank excavation that is designed to assist in detecting releases of liquid or vapor product from an underground storage tank system.
- 1.3.20** The *operational life* of an underground storage tank system is the period beginning when the system is first placed in service and ending when the system is properly removed or abandoned.
- 1.3.21** *Petroleum products* are hydrocarbons, including crude oil and crude oil fractions, that are liquid at 60°F and 14.7 pounds per square inch absolute.
- 1.3.22** A *pipe tightness test* is an air pressure test of underground product-handling piping and associated valves and fittings that is conducted before the product is introduced and the piping is covered with backfill. A pipe tightness test is conducted as follows:
- The piping to be tested is isolated and pressurized with compressed air to 150 percent of the maximum system operating pressure (or a minimum of 50 pounds per square inch gauge) for 1 hour.
  - All valves, fittings, and surfaces are coated with a soap solution and inspected for bubbles.
  - Leaks, as indicated by bubbles, are repaired, and the piping is retested as necessary.
- If the piping to be tested is installed and operational, a hydrostatic test of piping, as specified in NFPA 329, should be conducted.
- CAUTION:** Extreme care should be exercised in conducting the pipe tightness test. *Pressurized piping is potentially dangerous because of the possibility of violent rupture.* This test should be conducted with minimum exposure of personnel and without moving or disturbing the piping being tested. When the test is completed, the piping pressure and monitor-line pressure must be reduced during the remainder of construction to ensure that the lines are not damaged during backfilling and paving.



**1.3.23** A *precision test* is a test of the liquid-product-handling portion of an underground storage tank system, or a portion of the system, that meets the criteria of NFPA 329.

**1.3.24** A *private potable water well* is a well on private property that supplies potable water to on-site facilities.

**1.3.25** A *product-line leak detector* is a device that detects leaks or pressure losses in the pressurized piping of a remote pumping system.

**1.3.26** A *qualified person* is an individual, company, agency, or organization deemed qualified, based on education and/or experience in the area of interest, to perform a particular task or tasks.

**1.3.27** *Release* refers to any spill, leak, or escape of petroleum product from an underground storage tank system into groundwater, surface water, or soil.

**1.3.28** A *remote pumping system* (also known as a *submerged pumping system*) is a system in which one or more pumping units push petroleum product, via a pressurized piping system, to one or more points away from the tank or tanks.

**1.3.29** *Secondary containment* refers to any system in which an outer, or secondary, container or impervious liner prevents releases of petroleum product from the primary container from reaching the surrounding environment for a time sufficient to allow detection of the released product.

**1.3.30** A *sole-source aquifer* is an aquifer designated by the U.S. Environmental Protection Agency as being the only source of drinking water for a segment of the public.

**1.3.31** *Storage* refers to the deposition of a petroleum product in a container for later use. The term does not include collection of (a) overflows, drips, or spills in auxiliary containers (for example, sumps, catch basins, and drip-collection devices) or (b) hydraulic fluids or similar substances within machines (for example, hydraulic lifts and elevators).

**1.3.32** *Structure-to-soil potential* is the difference in electrical potential (measured as voltage) between a steel underground petroleum storage tank system and its surrounding soils.

**1.3.33** *Structure-to-structure potential* is the difference in electrical potential (measured as voltage) between adjacent underground steel structures.

**1.3.34** A *suction pumping system* is a system in which a pump at a dispensing island reduces pressure in the

product line to the underground storage tank to less than atmospheric pressure, causing product from the tank to be pulled to the island via the product suction line.

**1.3.35** A *tank tightness test* is an air pressure test of an underground storage tank that is conducted before the tank's installation and the introduction of product. A tank tightness test is conducted as follows:

a. All factory-installed bungs are removed from the tank, and a pipe-thread sealant certified for petroleum service is applied to them. The bungs are then replaced and tightened to ensure that no air is released during testing. Any temporary bungs should be replaced with solid bungs. Care should be taken to avoid cross-threading when the bungs are replaced.

b. A compressed-air source is applied to raise the internal tank pressure to between 3 and 5 pounds per square inch gauge. A pressure gauge with a maximum range of 10-15 pounds per square inch gauge should be used to confirm proper pressurization. Prior to pressurization, the external surface of the tank should be inspected for defects.

c. When the internal pressure is achieved, the compressed-air source should be disconnected from the tank, and the entire tank shell, as well as all seams, bungs, and manholes, should be uniformly coated and recoated as necessary with a soap solution. Leaks are detected by the presence of bubbles.

d. If bubbles are observed around fittings, the fittings should be checked for tightness and repaired as necessary. If leaks are detected in seams or the shell, the supplier and/or the manufacturer should be notified.

e. When the inspection is complete, the air pressure should be released.

**CAUTION:** A tank tightness test is a potentially dangerous procedure and should therefore be conducted with the following safety precautions:

a. Before any of the procedures described in 1.3.35 are initiated, the tank manufacturer's instructions should be consulted regarding specific testing requirements.

b. The internal tank pressure must not exceed 5 pounds per square inch gauge. *Personal injury and tank damage can result from overpressuring.*

c. A pressure gauge with a range of 10-15 pounds per square inch gauge is recommended so that the tester can accurately determine small pressure differences. *It is essential that neither a vacuum gauge nor a pressure gauge with a maximum range exceeding 15 pounds per square inch gauge be used.* Pressure gauges should be checked for proper operation and accuracy before being used.

d. In case of failure when the tank is pressurized, personnel should be kept well away from the ends of the tank, the bungs, and the manholes.

e. A pressure relief device, capable of relieving the total output of the compressed-air source at a pressure of not more than 6 pounds per square inch gauge, should be used to prevent overpressuring.

f. Piping or tanks that contain flammable or combustible liquids should not be pressure tested, either with air or with other gases. *Such testing would create a severe danger of rupture and consequent release of product to the environment, as well as the possibility of explosion and fire.*

**1.3.36** *Underground pipes* are pipes that are buried underground and connected to an underground storage tank. Underground pipes do not include vent pipes, fill pipes, or vapor recovery pipes.

**1.3.37** An *underground storage tank* is a container that has a capacity of more than 110 gallons, is used to store petroleum products for later use, and is buried completely underground.

Note: This definition applies only to this recommended practice and is not to be confused with the U.S. Environmental Protection Agency's definition of an underground storage tank.

**1.3.38** An *underground storage tank system (USTS)* is a petroleum product storage system that is completely underground. An underground storage tank system is generally composed of one or more storage tanks, product lines, pumps, vent lines, tank fill lines, vapor recovery pipes, and other appurtenances for storing, using, and/or dispensing petroleum products.

**1.3.39** An *underground transit structure* is a partially or totally buried structure designed to convey vehicles such as subway cars, trains, or motor vehicles.

**1.3.40** *Vapor recovery* refers to the control, containment, and/or disposition of petroleum product vapors from an underground storage tank system during product delivery and dispensing operations.

**1.3.41** *Vaulting* refers to the total or partial enclosure of an underground storage tank system (except vent lines) with a rigid material such as concrete or steel to retain released product until it can be detected.

**1.3.42** *Visual inspection* refers to examination, with the naked eye, of a liquid sample removed from an observation or monitoring well to detect the presence of petroleum product.

**1.3.43** A *wellhead zone of influence* is the subsurface area surrounding a municipal water well through which

petroleum products are reasonably likely to reach the well in the time necessary to detect the release, terminate the source, and restrict further movement of the product plume.

## 1.4 Referenced Publications

The editions of the following standards, codes, and specifications that are in effect at the time of publication of this recommended practice are cited herein:

API	
Std 650	<i>Welded Steel Tanks for Oil Storage</i>
RP 1604	<i>Removal and Disposal of Used Underground Petroleum Storage Systems</i>
RP 1621	<i>Bulk Liquid Stock Control at Retail Outlets</i>
RP 1626	<i>Storing and Handling Ethanol and Gasoline-Ethanol Blends at Distribution Terminals and Service Stations</i>
RP 1627	<i>Storage and Handling of Gasoline-Methanol/Cosolvent Blends at Distribution Terminals and Service Stations</i>
Publ 1628	<i>Underground Spill Cleanup Manual</i>
RP 1631	<i>Interior Lining of Existing Steel Underground Storage Tanks</i>
RP 1632	<i>Cathodic Protection of Underground Petroleum Storage Tanks and Piping Systems</i>
RP 1635	<i>Management of Underground Petroleum Storage Systems at Marketing and Distribution Facilities</i>
RP 1637	<i>Using the API Color-Symbol System to Mark Equipment and Vehicles for Product Identification at Service Stations and Distribution Terminals</i>
Publ 2005	<i>Service Station Safety</i>
Publ 2015	<i>Cleaning Petroleum Storage Tanks</i>
Publ 2217	<i>Guidelines for Confined Space Work in the Petroleum Industry</i>
Publ 2219	<i>Safe Operation of Vacuum Trucks in Petroleum Service</i>
ASME <sup>1</sup>	
B16.3	<i>Malleable Iron Threaded Fittings, Class 150 and 300</i>

<sup>1</sup>American Society of Mechanical Engineers, 345 East 47th Street, New York, New York 10017.

B16.39	<i>Malleable Iron Threaded Pipe Unions, Class 150, 250 and 300</i>		<i>or Submerged Liquid Storage Systems</i>
B36.10M	<i>Welded and Seamless Wrought Steel Pipe</i>	NFPA <sup>5</sup>	
		30	<i>Flammable and Combustible Liquids Code</i>
ASTM <sup>2</sup>			
C 33	<i>Specification for Concrete Aggregates</i>	30A	<i>Automotive and Marine Service Station Code</i>
D 2996	<i>Specification for Filament-Wound Reinforced Thermosetting Resin Pipe</i>	31	<i>Installation of Oil Burning Equipment</i>
D 4021	<i>Specification for Glass Fiber-Reinforced Polyester Underground Petroleum Storage Tanks</i>	329	<i>Underground Leakage of Flammable and Combustible Liquids</i>
G 57	<i>Method for Field Measurement of Soil Resistivity Using the Wenner Four-Electrode Method</i>	OSHA <sup>6</sup>	
			<i>Safety and Health Regulations for Construction (29 CFR 1926.652)</i>
EPA <sup>3</sup>		STI <sup>7</sup>	
530-SW-85-023	<i>The Interim Prohibition: Guidance for Design and Installation of Underground Storage Tanks (August 1986)</i>		<i>Standard for Dual-Walled Underground Storage Tanks</i>
NACE <sup>4</sup>		UL <sup>8</sup>	
RP-01-69	<i>Control of External Corrosion on Underground or Submerged Metallic Piping Systems</i>	58	<i>Steel Underground Tanks for Flammable and Combustible Liquids</i>
RP-02-85	<i>Control of External Corrosion on Metallic Buried, Partially Buried,</i>	87	<i>Power-Operated Dispensing Devices for Petroleum Products</i>
		1316	<i>Glass-Fiber-Reinforced Plastic Underground Storage Tanks for Petroleum Products</i>

## SECTION 2—PREINSTALLATION SITE ANALYSIS

### 2.1 General

**2.1.1** Because many site-specific factors related to soil conditions and drainage affect the operational life of a USTS, it may be necessary to conduct a preinstallation site analysis. Such factors include but are not limited to soil resistivity, acidity (pH), moisture content, sulfide content, structure, and the possible presence of contamination. API Recommended Practice 1632 and NACE RP-01-69 and RP-02-85 provide further information on the effects of these and other site-specific factors. The preinstallation site analysis should also include an evaluation of possible requirements for secondary containment (see 2.2 and 6.3).

**2.1.2** The purpose of the preinstallation site analysis is to characterize the corrosivity and stability of the soil at the selected site and to evaluate the site-specific needs for groundwater protection. Soil corrosivity need not be evaluated if tanks and piping to be installed are made of fiberglass-reinforced plastic (FRP). The preinstallation site analysis should also include the location and identification of nearby structures, such as utility lines and sewer lines, that may influence the location and design of the USTS.

**2.1.3** When a USTS is to incorporate bare or coated metallic components in physical contact with surrounding backfill, the preinstallation site analysis should

<sup>2</sup>American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pennsylvania 19103.

<sup>3</sup>U.S. Environmental Protection Agency, Office of Underground Storage Tanks, 401 M Street, S.W., Washington, D.C. 20460.

<sup>4</sup>National Association of Corrosion Engineers, P.O. Box 218340, Houston, Texas 77218.

<sup>5</sup>National Fire Protection Association, Batterymarch Park, Quincy, Massachusetts 02269-9990.

<sup>6</sup>Occupational Safety and Health Administration, U.S. Department of Labor, Washington, D.C. 20402.

<sup>7</sup>Steel Tank Institute, 728 Anthony Trail, Northbrook, Illinois 60062.

<sup>8</sup>Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, Illinois 60062.

include a determination of the soil conditions described in 2.1.1 to assist in the design of a cathodic protection system. If USTS components are to be installed with factory-installed, preengineered cathodic protection systems, the manufacturer or a qualified person should be consulted to determine the adequacy of the preengineered system to protect against corrosion, given the subsurface conditions at the installation site.

**2.1.4** The preinstallation site analysis should include a determination of the soil stability and soil structure with respect to all systems to be installed.

**2.1.5** Determination of normal and expected high water tables and site drainage characteristics, as well as the potential for flooding at the site, is an important part of the preinstallation site analysis, since it aids in assessing the need for underground tank anchorage (see 6.2). The expected high water table may determine the method of release detection (see Section 8). Determination of these site characteristics is necessary regardless of whether steel or FRP tanks are to be used.

## SECTION 3—MATERIALS AND EQUIPMENT

### 3.1 General

The choice of the materials to be used in a USTS depends on many factors, including site and climatic conditions; risk presented to the public and the environment; availability of qualified personnel for installation, inspection, and maintenance of the system; and initial and operating costs. The authority having jurisdiction should be consulted regarding any requirements concerning materials. Manufacturers can also provide information related to material specifications and performance.

### 3.2 Federal Requirements

**3.2.1** When this edition was being prepared, new federal legislation was in effect that specified materials and performance criteria for USTSs. These provisions, termed *The Interim Prohibition* (EPA 530-SW-85-023), apply to USTSs installed after May 8, 1985, and include the following requirements:

- a. USTSs shall be made of or coated with a noncorrosive material or shall be cathodically protected against corrosion.
- b. USTSs shall be constructed to prevent the release of their contents during their operational life.
- c. USTSs shall be compatible with their contents.

### 2.2 Secondary Containment

**2.2.1** Secondary containment provides additional protection against product releases to the environment. Secondary containment is designed for application in areas or situations in which petroleum product releases would present immediate health and safety hazards or produce severe environmental damage (see 6.3).

**2.2.2** Secondary containment or equivalent protection is recommended for new installations when sole-source aquifers that underly the location of the USTS are determined to warrant such protection, when groundwater below the location is within a wellhead zone of influence, when a private potable water well is within 300 feet of the location, or when the USTS is within 100 feet of an underground transit structure. The authority having jurisdiction should be consulted regarding specific requirements for secondary containment.

EPA 530-SW-85-023 should be consulted for further information on these provisions, which will remain in effect until EPA develops specific regulations.

**3.2.2** Subtitle I of the Federal Resource Conservation and Recovery Act requires each owner to register every new underground tank within 30 days after the tank is brought into use. Federal, state, and local registration requirements should be reviewed when new tanks are installed.

### 3.3 Material Specifications

**3.3.1** The materials used in USTSs should meet the following criteria:

- a. Steel tanks should meet the requirements of UL 58 and the *STI Standard for Dual-Walled Underground Storage Tanks*.
- b. FRP tanks should meet the requirements of UL 1316 and ASTM D 4021.
- c. Steel pipe should meet the requirements of ASME B36.10M, Schedule 40, for either galvanized or wrapped black iron.
- d. FRP pipe should meet the requirements of ASTM D 2996.
- e. Threaded fittings should meet the requirements of ASME B16.3 for 150-pound malleable iron.



f. Unions should meet the requirements of ASME B16.39 for 150-pound malleable iron.

**3.3.2** When FRP tanks and piping are specified, the manufacturer should be asked to certify that the equipment is safe for use with the particular product grades to be handled (see API Recommended Practices 1626 and 1627).

### 3.4 Handling

**3.4.1** To prevent damage to coatings and structure, tanks should be handled with care during transit, storage, and installation. Tanks should not be rolled, dropped, or dragged.

**3.4.2** Chains, cable, or other lines should not be placed around the tank to lift or move it; however, rope or strapping that will not damage the coating may be used to secure the tank during transit.

**3.4.3** Lifting lugs attached by the manufacturer provide a safe and effective means of lifting or moving the tank. To lift or move a tank with multiple lifting lugs, chains or cable of sufficient length should be attached to the lugs and the lifting equipment so that the angle between the vertical and one side of the chain to a lifting lug is not greater than 30 degrees. A spreader bar can be used to ensure that the angle does not exceed 30 degrees. Handlines should be attached to the tank to provide a means of manually controlling its movement and placement.

**3.4.4** Tanks stored temporarily at the installation site should be located away from areas of activity where the coating or structure could be damaged. Efforts should be made to ensure that stored tanks do not interfere with the normal flow of vehicles or pedestrians. The tanks should be placed in a location that will minimize the need for further movement prior to installation.

**3.4.5** Nonabrasive chocks (such as rubber tires) should be used to prevent the tank from moving during storage. If high winds are expected, tanks should be tied down with nylon rope at least  $\frac{1}{2}$  inch in diameter. The rope should be secured to stakes large enough to provide adequate restraint. Tie-down ropes should be secured through the lifting lugs.

**3.4.6** Piping should be handled with care to prevent damage to coatings or structure. Bending, crushing, or otherwise stressing pipe should be avoided during transit, storage, and installation.

**3.4.7** Single-wall FRP tanks should be vented to the atmosphere during storage and installation. Double-wall FRP tanks are shipped and stored with a vacuum

on their interstice. This vacuum should be maintained until the tank tightness test is conducted.

## 3.5 Preinstallation Inspection and Testing

### 3.5.1 GENERAL

**3.5.1.1** Upon delivery at the installation site and just prior to installation, tanks and piping should be carefully inspected to ensure that they comply with applicable specifications and to detect any evidence of damage to coatings or structure.

**3.5.1.2** When possible, damaged coatings should be repaired at the installation site with manufacturer-supplied materials and in accordance with the manufacturer's instructions. If this is not possible or if significant damage, such as denting, puncturing, or cracking, has occurred, the manufacturer should be employed to repair the equipment or coatings and to recertify or replace the tank as required.

**3.5.1.3** Before a tank is installed, its inside diameter should be measured to confirm the specification supplied by the manufacturer. The measurement should be permanently recorded for comparison with post-installation measurements and for future reference. The inside diameter of an installed tank should be measured from outside the tank.

**CAUTION:** Tanks should not be entered for any purpose unless proper safety precautions, as outlined in API Publication 2217, are taken.

### 3.5.2 TESTING OF SINGLE-WALL TANKS

Prior to installation, each underground tank should be subjected to a tank tightness test (see 1.3.35).

### 3.5.3 TESTING OF DOUBLE-WALL TANKS

**3.5.3.1** Double-wall tanks provide a form of secondary containment in that they contain an internal volume, called an *interstice*, between the tank walls. This space may also be referred to as an *interstitial space*, an *annulus*, or an *annular space*. The interstice is a feature that provides for containment and detection of releases and is not meant to provide permanent storage of product.

**3.5.3.2** When this edition was being prepared, the NFPA had not yet established procedures for preinstallation tightness testing of double-wall tanks. Nevertheless, both the inner and the outer shell should be tested for tightness prior to installation. It is therefore

important that the manufacturer's instructions be followed during preinstallation tightness testing of double-wall tanks.

### 3.5.4 TESTING OF PIPING AND OTHER EQUIPMENT

**3.5.4.1** Piping and other product-handling equipment are not generally subjected to preinstallation tightness testing at the jobsite. Instead, when the piping is in-

stalled and before the backfill is placed, the piping should be isolated from the tanks and tested (see 10.2).

**3.5.4.2** If impervious liners are used in installations as secondary containment, they should be carefully inspected for damage and should be tested at the jobsite after they are installed in the excavation but before tanks or backfill is placed. The manufacturer's testing instructions should be followed, with special attention given to the liner seams. Any repairs should be conducted in accordance with the manufacturer's instructions.

## SECTION 4—REMOVAL AND DISPOSAL OF USED STORAGE SYSTEMS

### 4.1 Safety Considerations

In some cases, an existing USTS must be partially or totally removed before a new system is installed. Because of the fire and safety hazards related to the removal of existing systems, specific safety precautions must be taken. API Recommended Practice 1604 and API Publications 2217 and 2219 provide appropriate safety information and procedures. Local fire officials should be consulted before any action is taken.

### 4.2 Considerations for Partial System Removal

If only part of an existing USTS is to be removed, care should be taken not to disturb backfill or components of the system that will remain in place. The following specific precautions should be taken:

- a. Product should be removed from all existing USTSs at the jobsite, and the tanks in these systems should be made vapor free before excavation is initiated. (API Recommended Practice 1604 describes vapor-freeing procedures.)
- b. Care should be taken when existing equipment and backfill are removed so that other existing tanks and piping are not damaged or undermined. Removing and replacing backfill around existing piping and tanks can cause stresses that may damage coatings and/or structure.
- c. If the existing tanks that will be left intact and the new equipment that will be installed are both steel, consideration should be given to minimizing the electrochemical corrosion effect that the existing tanks might have on the new equipment. This effect is of increased concern when all the adjacent USTSs are not cathodically protected and electrically connected or when one of the USTSs has impressed-current cathodic protection and is not electrically connected with adjacent USTSs.

Newer tanks can become anodic to older steel tanks and can corrode much faster than expected if a properly designed cathodic protection system is not installed (see API Recommended Practice 1632 and NACE RP-02-85). The following actions can be taken to minimize this effect:

1. Using nonmetallic materials (such as FRP) in the system to be replaced.
2. Employing cathodic protection devices on the new and existing systems (see API Recommended Practice 1632).
3. Replacing all adjacent USTSs with new equipment, using either steel or nonmetallic materials.
- d. The authority having jurisdiction should be consulted regarding any regulations that cover the proposed work.

### 4.3 Repair of Underground Tanks

If a steel tank is to be repaired by applying an interior lining, all other steel underground storage tanks at the facility should be similarly treated. Before any work is begun, the authority having jurisdiction should be consulted regarding any regulations that cover the repair plans. (See API Recommended Practice 1631 for further information on procedures and safeguards for interior tank repair and lining.)

### 4.4 Contaminated Backfill

**4.4.1** When an existing USTS is partially or totally removed, a small amount of contaminated backfill may be encountered. Backfill can be contaminated by minor spills and drips during previous operation of the facility or by minor spills and drips during removal of equipment, despite efforts to drain and pump product from the equipment before removal (see API Recommended Practice 1604). Contaminated backfill may be a fire and environmental hazard.

4.4.2 Spills and drips should be contained to the maximum extent possible to minimize contamination during removal. If severe contamination has occurred, local environmental officials, the fire marshal, or the EPA must be notified. Local officials may require isolation and special handling and/or disposal of contaminated backfill materials (see API Publication 1628).

## 4.5 Disposal of Used Equipment

API Recommended Practice 1604 suggests appropriate disposal methods for used petroleum product storage and handling equipment. The authority having jurisdiction should be consulted before any action is taken.

## SECTION 5—EXCAVATION

### 5.1 Safety Considerations

5.1.1 Any earth excavating procedure presents safety hazards related to the presence of unstable soils, water, released product, and moving equipment. Personnel involved in excavation, equipment installation, and backfilling should be knowledgeable about and should follow the safety standards given in OSHA's *Safety and Health Regulations for Construction* (29 CFR 1926.652).

5.1.2 The excavation should provide adequate space for the installation of tanks, piping, and ancillary equipment. Special attention should be given to sloping or shoring the sides of the excavation to make them stable.

**CAUTION:** Personnel should not enter an unshored or unsloped tank excavation unless the excavation has been determined to be stable.

### 5.2 Location of Tanks

5.2.1 Tanks should be located to minimize the amount of maneuvering necessary for the tank truck making the product delivery to reach the fill openings. Whenever possible, the delivery should be able to be accomplished without having to move the truck (see Figures 1 and 2).

5.2.2 Tanks should be located so that the tank truck making the product delivery will not be on a public right-of-way, block motorists' views of roadways, or impede the flow of vehicles or pedestrians.

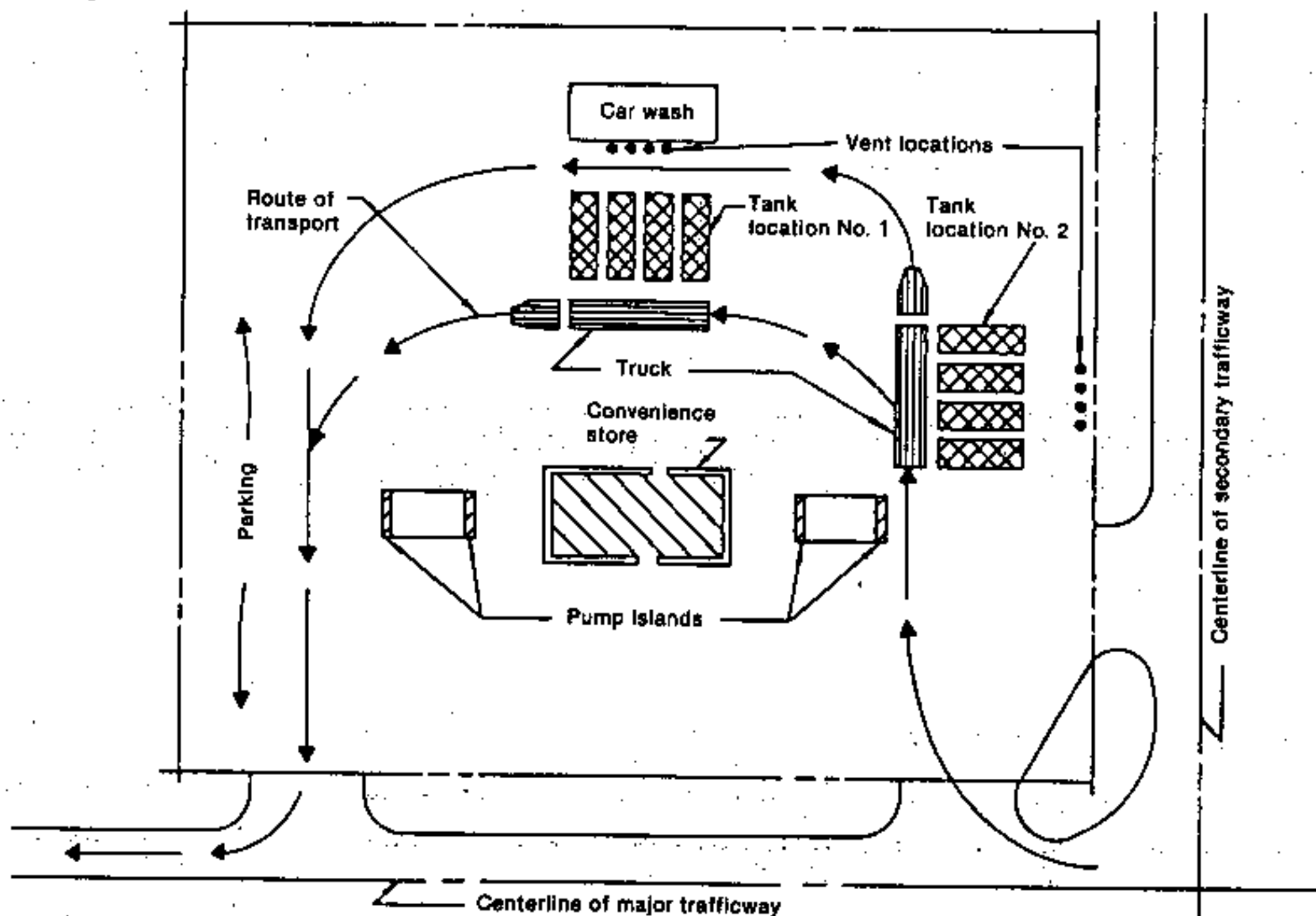
5.2.3 Local regulations usually specify permissible distances from underground storage tanks to property lines or buildings. If a tank is to be placed near a building foundation, care should be taken to prevent damage to the building or the tank. If soil instability creates concern about damage, the tank should be positioned so that the angle from the bottom of the building

foundation to the nearest edge of the bottom of the tank excavation does not exceed 45 degrees. Tanks should not be located less than 3 feet from the property line of any adjacent property on which a structure can be built.

### 5.3 Excavation Dimensions

5.3.1 Excavations for steel tanks should be large enough to provide a minimum clearance of 12 inches between the ends and sides of tanks and the sides of the excavation. Excavations for FRP tanks should be large enough to provide a minimum clearance of 18 inches. Steel tanks should be at least 12 inches apart, and FRP tanks should be at least 18 inches apart. Other distances may be required by the manufacturer.

5.3.2 For both steel and FRP tanks, the excavation should be deep enough to provide for a backfill depth of at least 12 inches below the bottom of the tank, with or without a hold-down pad. The burial depth of the tank depends on local regulations, the type of finished surface to be applied, soil conditions, topography, the vertical distance needed to provide the required slope for vapor and product lines, suction lift requirements, the need for a piping cover, the bedding thickness, the hold-down pad (if required), and the manufacturer's recommendations. The cover over the tanks (backfill and/or paving) will vary depending on whether there will be traffic over the tanks. In areas that are not subject to traffic, the cover should consist of a minimum of 24 inches of backfill, or a minimum of 12 inches of backfill plus at least 4 inches of reinforced concrete. In areas that are subject or are likely to be subject to traffic, the cover should consist of a minimum of 36 inches of well-tamped backfill, or a minimum of 18 inches of well-tamped backfill plus at least 6 inches of reinforced concrete or 8 inches of asphaltic concrete.



## Notes:

1. The optimum turning radius for a transport truck is 50 feet.
2. The transport truck should not be required to back up.
3. With both suction and remote pumping systems, product lines should be of a practical length.

Figure 1—Typical Plot Plan Showing Possible Tank Locations: Convenience Store and Car Wash

## SECTION 6—EQUIPMENT PLACEMENT, ANCHORAGE, SECONDARY CONTAINMENT, AND BALLASTING

### 6.1 Placement

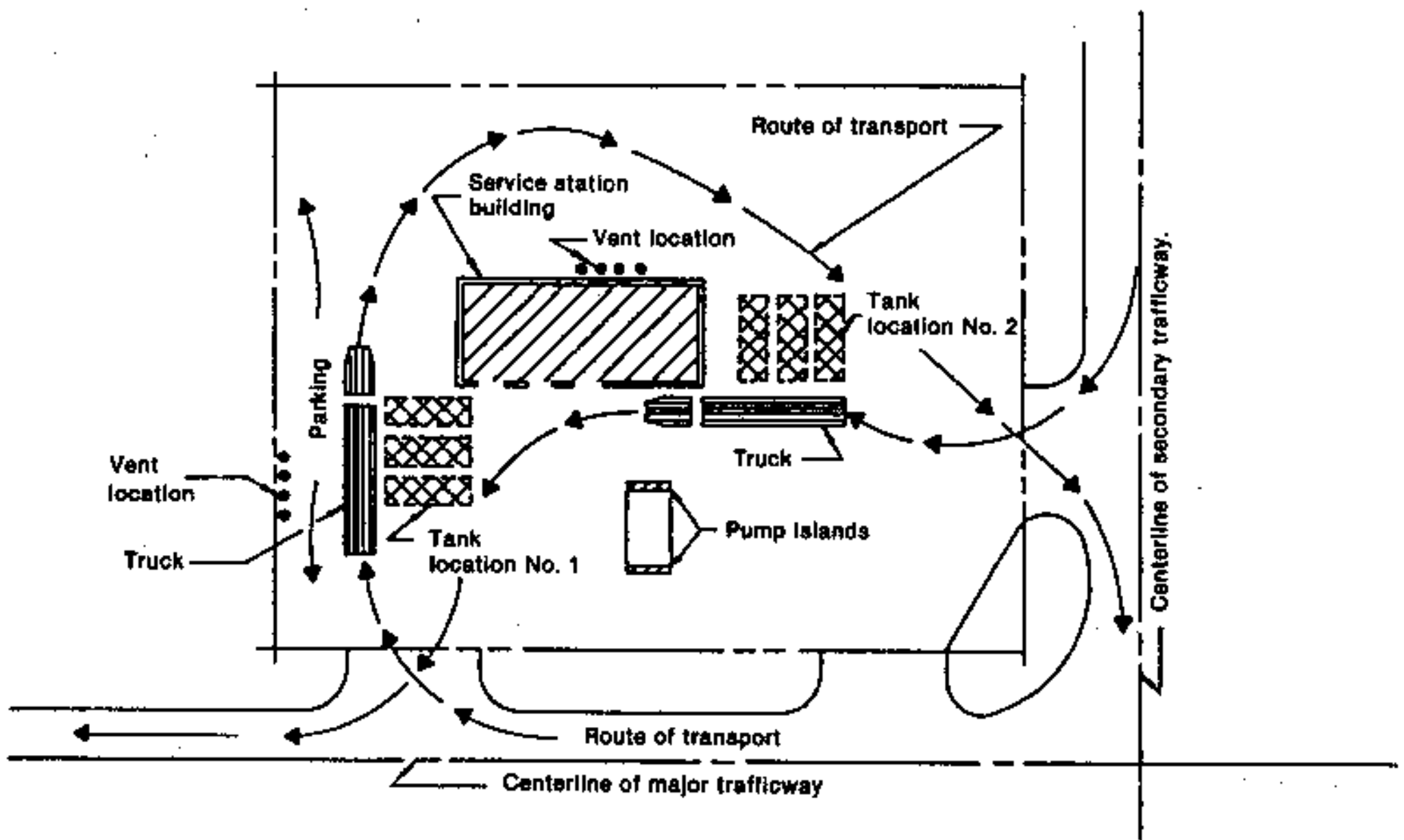
6.1.1 Steel and FRP tanks should be placed on a bed of suitable backfill (see Section 10) that has been graded, leveled, and compacted to the depth specified in 5.3.2. If a concrete hold-down pad is required, as described in 6.2.3, at least 12 inches of compacted backfill should cover the pad. An underground tank should never be installed directly on a hold-down pad. Care should be taken to prevent impact between the tank and the hold-down pad or other anchorage when the tank is lowered onto the pad or moved into the excavation. The

use of handlines for manual control will facilitate this procedure.

6.1.2 Suitable backfill should be placed carefully along the bottom quadrant of the tank to prevent movement and ensure proper support.

6.1.3 It is occasionally necessary or advisable to install more than one storage tank for a given product. Such tanks may be interconnected by means of a siphon connection, which permits the equalization of the product level in the connected tanks (see 9.2.4). Interconnected





## Notes:

1. The optimum turning radius for a transport truck is 50 feet.
2. The transport truck should not be required to back up.
3. With both suction and remote pumping systems, product lines should be of a practical length.

Figure 2—Typical Plot Plan Showing Possible Tank Locations: Service Station

tanks should have the same diameter and should be installed with their bottoms at the same depth (see Figures 3 and 4).

## 6.2 Anchorage

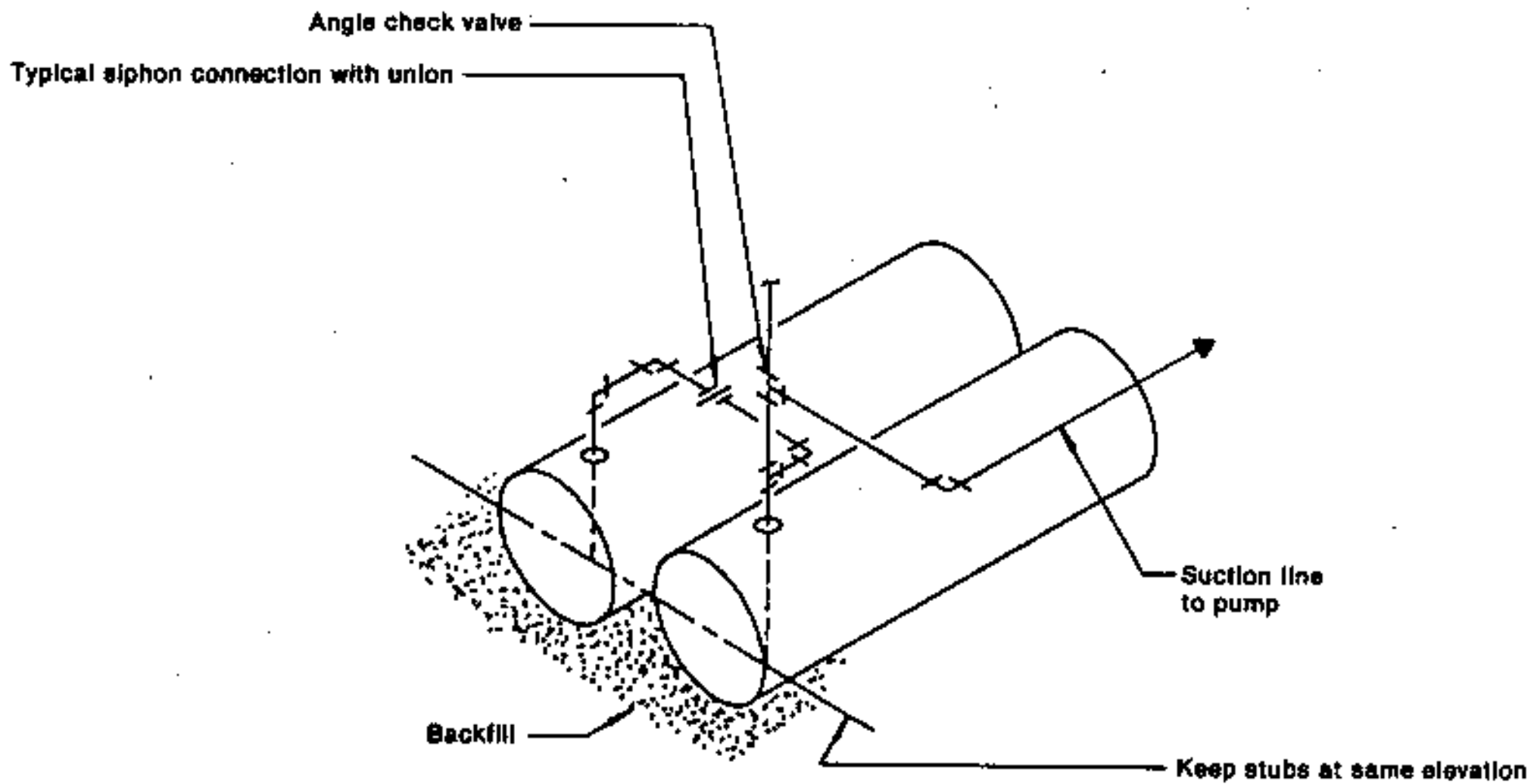
**6.2.1** An underground tank can float if it is submerged in a high water table or as a result of flooding, even if the tank is partly or completely full of product. Product weight, tank weight, the type of tank cover (backfill and paving), and the height of water around the tank all have an effect on whether a tank will float.

**6.2.2** All of the factors given in 6.2.1 should be considered in determining whether anchorage is required. If a high water table exists or if flooding can be expected, tanks should be anchored. The presence of these conditions should have been identified during the preinstallation site analysis (see Section 2).

**6.2.3** Tanks can be secured against flotation in many ways. The following methods are the most common:

- a. Placing a concrete slab under the tanks, with a 12-inch cushion of proper backfill between the bottom of the tank and the slab.
- b. Burying concrete deadmen on either side of the tank.

Each of the anchorage methods above requires that anchor straps be installed over the tank and secured to the anchorage (see Figure 5). The straps should be installed in accordance with the manufacturer's instructions, should not damage the tanks or their coatings, and if the tank is steel should be electrically isolated from the tank (see 7.4.2). It is particularly important to follow the manufacturer's instructions when anchor straps are installed over fiberglass tanks, since special straps, which must be used at specific locations on the tank, are required.



**Notes:**

1. If Stage I or Stage II vapor recovery is required, it should be installed as shown in Figure 16.
2. Other tank piping details should be as shown in Figure 16.

**Figure 3—Typical Suction Pump System: Manifolded Tanks**

**6.2.4** The following two methods of securing tanks against flotation are sometimes used:

- a. Increasing the tank's burial depth to increase the hold-down weight.
- b. Increasing the thickness and/or extent of a concrete paving slab over the tank.

**6.2.5** In considering any of the options described in 6.2.3 and 6.2.4, the requirements for burial depth given in 5.3.2 should be taken into account.

**6.2.6** When it has been determined that anchorage is necessary, professional assistance should be obtained to determine which of the options described in 6.2.3 and 6.2.4 should be used and to help in designing the installation. This assistance may be available from the tank manufacturer, professional engineers, or professional tank installers.

### 6.3. Secondary Containment

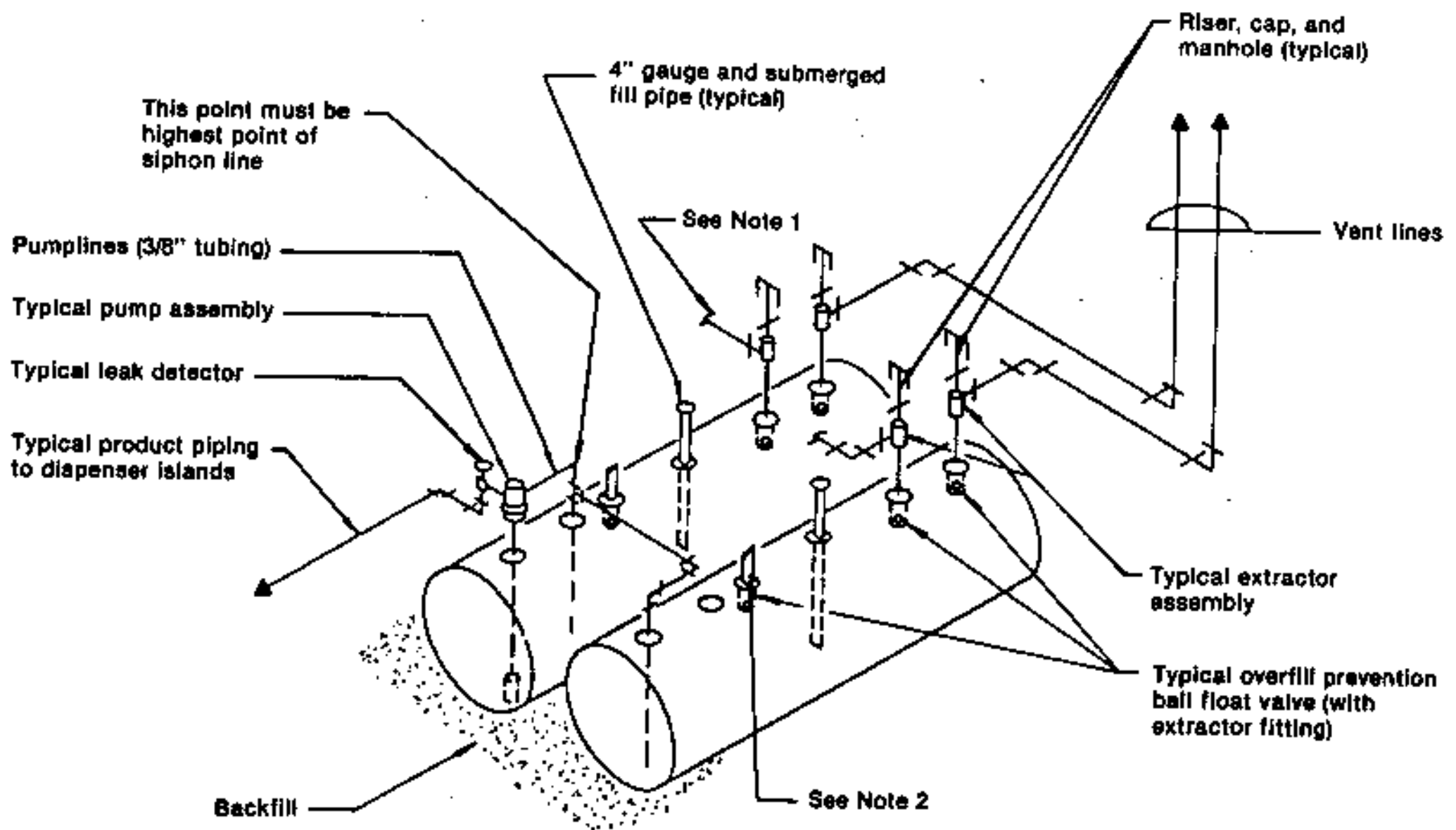
**6.3.1** If secondary containment is deemed necessary or is required based on the criteria given in 2.2.2, it must be included as part of the equipment installation. The

following components of the installation may require secondary containment:

- a. Tanks.
- b. Piping.
- c. Dispensers.
- d. Submerged pumps (which may be inside the tanks' secondary containment).
- e. Tank fill pipes (which may be inside the tanks' secondary containment).

**6.3.2** Secondary containment can be provided by the following means:

- a. Impervious liners for tanks.
- b. Impervious liners under lines (which should be drained to a sump in the tank pit).
- c. Containment under dispensers.
- d. Containment around submerged pumps.
- e. Containment around fill manholes.
- f. Double-wall tanks (with a tank excavation sump for line and dispenser containment and with containment around submerged pumps and around fill manholes).
- g. Double-wall pipe (which should be drained to a sump in the tank pit).



## Notes:

1. If required, a Stage II vapor recovery line should run to the vapor collection manifold and then to the dispenser islands. If the vapor recovery system is not manifolded, each line should go to the dispenser islands. A float valve, extractor, riser, cap, and manhole should be included for each tank. (The arrangement shown is typical.)
2. If required, a Stage I vapor recovery riser should run to the vapor collection manifold, with one surface pickup point. If the vapor recovery system is not manifolded, each riser should go to a separate surface pickup point. Each riser pipe should be connected to a ball float valve. (The arrangement shown is typical.)
3. Tank bottoms should all be at the same elevation.
4. The bottom of all siphon stubs should be at the same elevation.
5. See Figure 12 for details of tank piping.

Figure 4—Typical Remote-Pumping Manifolded Tank Siphon System  
(Shown With Stage I and Stage II Vapor Recovery)

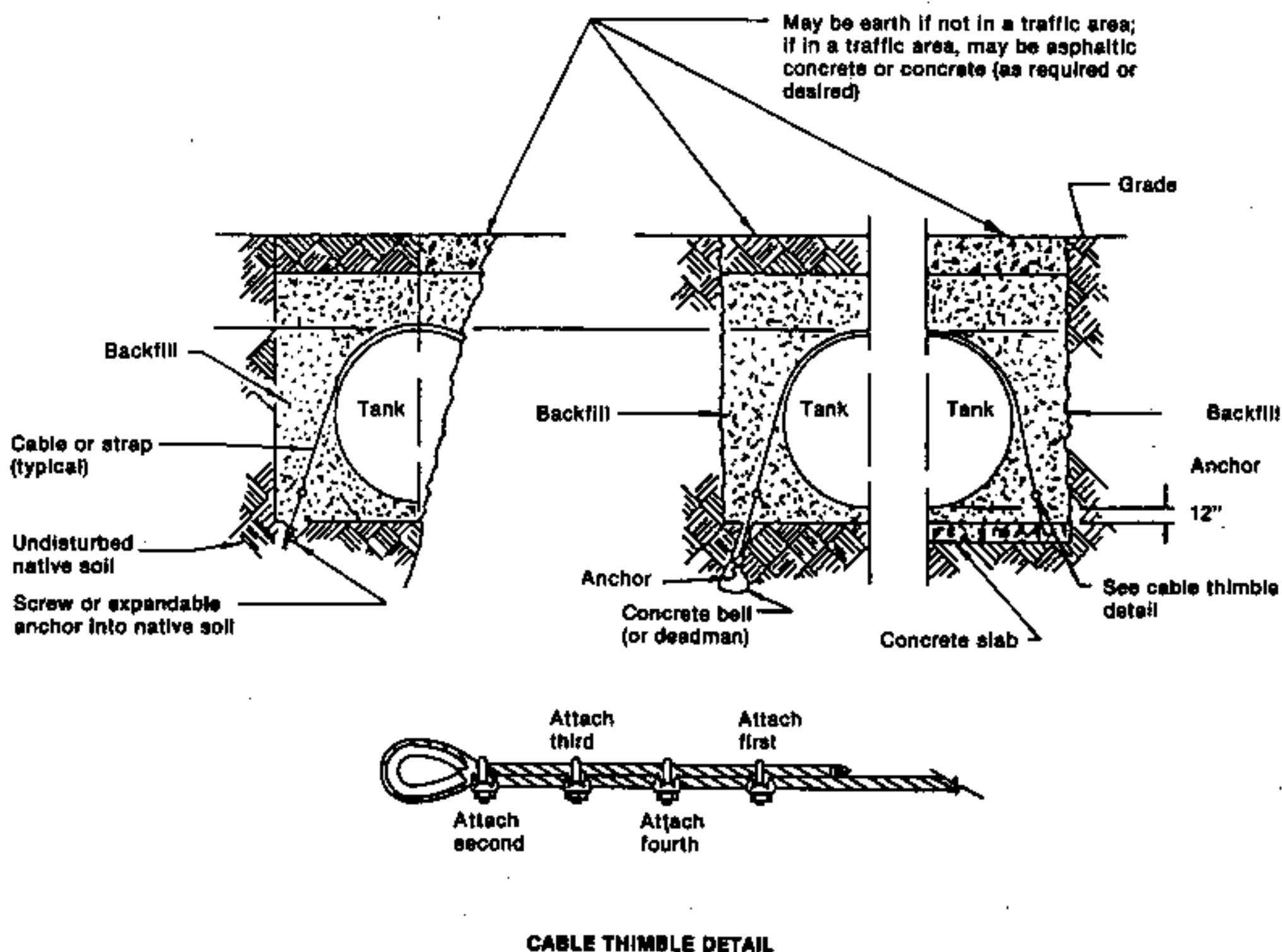
**6.3.3** Secondary containment for tanks can be provided by the use of double-wall tanks (see 1.3.6) or impervious liners (see 1.3.11) for the tank excavation. Another form of secondary containment can be provided by impervious soil treatment (see 1.3.12), which decreases the permeability of the soil beneath the tanks. The type of secondary containment used depends on site conditions and economic factors.

**6.3.4** Secondary containment for piping can be provided by the use of double-wall pipe (see 1.3.5) or impervious liners (see 1.3.11) for the pipe trench. If

double-wall pipe is used, it must be installed in accordance with the manufacturer's instructions.

**6.3.5** Concrete vaulting (see 1.3.41) should not be used to provide secondary containment for tanks or lines, because of the vaulting's propensity for cracking and structural degradation as a result of freeze-thaw cycles, aggressive soil conditions, and geologic shifts. The coatings used on vaulting can also degrade over time.

**6.3.6** Various combinations of secondary containment can be used (see Figure 6). If double-wall tanks are used, containment should be provided for the fill manholes.



**Notes:**

1. The tank manufacturer should be consulted for recommendations for anchorage and installation.
2. This figure shows a tank installation where subsurface water is present.

**Figure 5—Typical Anchorage for Underground Tank**

In addition, a sump is usually provided for the dispenser, line containment systems, and submerged pumps. Otherwise, a small spill at the fill pipe or a leak at the submerged pump could appear to be a tank or line leak requiring extensive and costly investigation. For secondary containment to be effective and to eliminate unnecessary and costly investigation, the source of any free product must be easily identifiable.

## 6.4 Ballasting

**6.4.1** Underground tanks should be ballasted with product as soon as possible after the tanks are installed and backfill has been placed around the tank (see Sec-

tion 10). At no time during the backfilling process should the height of the ballast in the tank exceed the level of backfill around the tank.

**6.4.2** Water may be used as an alternative ballast, but the installation of submerged pumping units in the tank must be deferred until after the water ballast is removed. If ballasting is necessary to prevent flotation of the tank (as a result of a high water table or flooding), water ballast should be the first choice.

**6.4.3** When gasoline is used as ballast, the tanks should be vented to the atmosphere in accordance with NFPA 30.

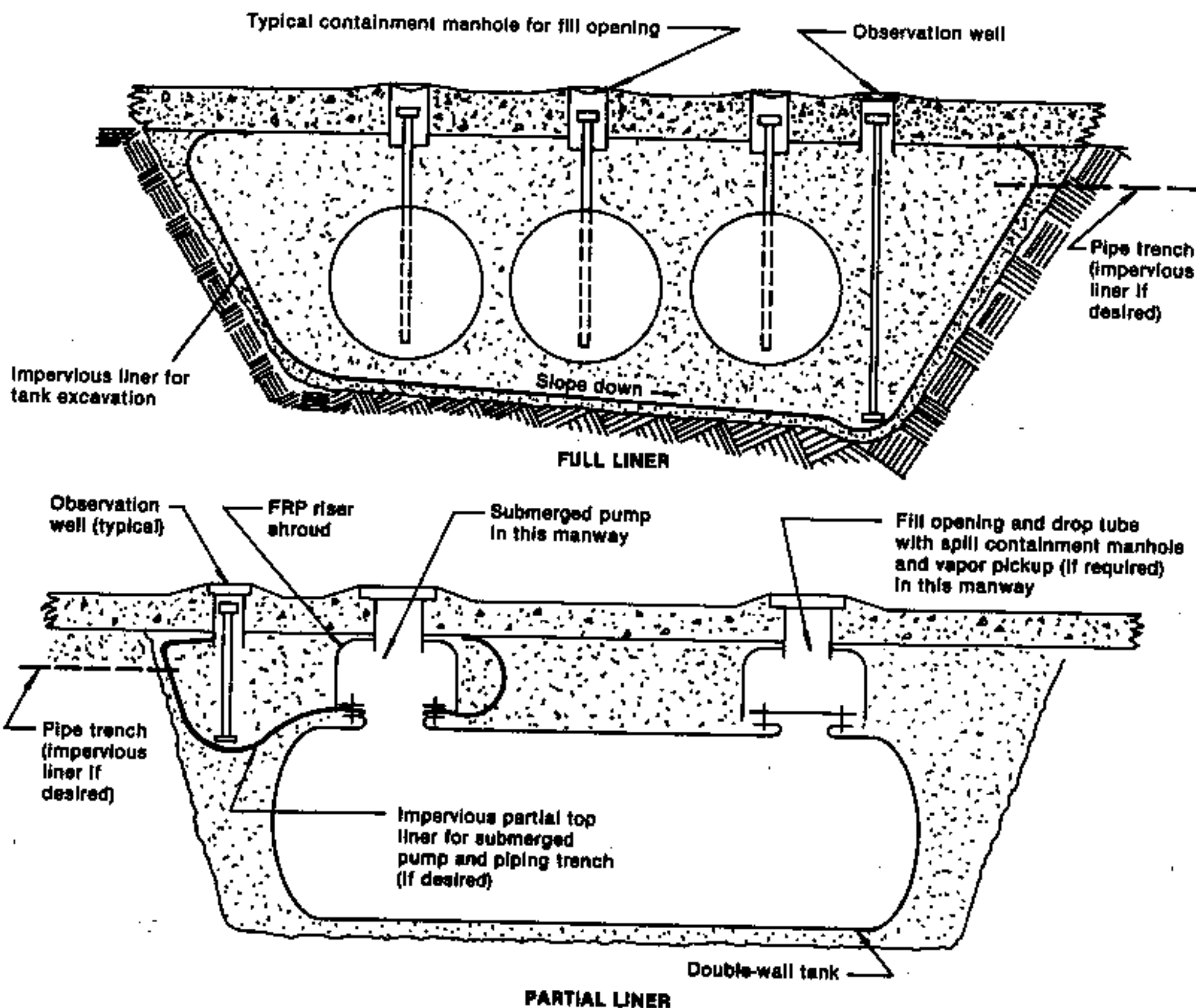


Figure 6—Typical Impervious Liners

6.4.4 If tanks are to be ballasted before the backfilling process is completed, the manufacturer's special instructions must be followed.

6.4.5 When product is used as ballast, care is required in handling, controlling inventories, and safeguarding against fires, accidents, and thefts. All fill caps and pumps should be kept locked when the system is unattended.

## SECTION 7—CATHODIC PROTECTION

### 7.1 General

7.1.1 EPA 530-SW-85-023 contains the following requirements for each new tank and its piping:

a. They must be compatible with the substance to be stored.

b. They must be cathodically protected or constructed of noncorrosive material or of steel clad with non-corrosive material.

c. They must be designed to prevent the release or threatened release of any stored substance for the operational life of the system.

EPA 530-SW-85-023 does allow an exemption from corrosion control: If the soil at a site has a resistivity (electrical resistance determined across a 1-centimeter cube of soil) greater than or equal to 12,000 ohm-centimeters, measured as specified in ASTM G 57, cathodic protection may be eliminated. (For additional information and details about cathodic protection, see API Recommended Practice 1632 and NACE RP-02-85.)

**7.1.2** There are two systems of cathodic protection: the *impressed-current system* and the *sacrificial-anode system*, which are discussed in 7.2 and 7.3, respectively. Both systems operate more efficiently with properly coated steel tanks and piping.

## 7.2 Impressed-Current Protection

An impressed-current system can be designed to protect steel tanks, steel underground piping, and other steel underground equipment at the site. Impressed-current systems use alternating current supplied by the electrical system at the site. The alternating current is converted to direct current by a rectifier, which is electrically connected to impressed-current anodes. The direct current flows from the rectifier to the anodes, through the soil to the steel equipment, and back to the rectifier. Corrosion is controlled by managing the flow and direction of the current. Changes or additions of USTS equipment may require alterations in existing impressed-current systems.

## 7.3 Sacrificial-Anode Protection

**7.3.1** A sacrificial-anode system protects steel structures by managing the flow of electrical currents from the structures. Sacrificial anodes are electrically connected to the structure to be protected. Underground electrical currents exit to the surrounding soil through an anode that corrodes, rather than the structure corroding.

**7.3.2** Sacrificial-anode protection can be provided by purchasing preengineered cathodically protected steel tanks. These tanks are delivered to the site properly coated, with sacrificial anodes attached and electrically connected to the tanks, ready for installation.

**7.3.3** If steel tanks are installed without attached preengineered anodes, separate field-installed sacrificial anodes or an impressed-current system should be employed to protect the tanks.

**7.3.4** When a sacrificial-anode system is used, piping must be electrically isolated from the tank and protected

separately by field-installed sacrificial anodes (see 7.4.1).

**7.3.5** The steel tanks and steel piping discussed in 7.3.2 through 7.3.4 must be coated to reduce their current requirements to levels that can be supplied over a long period of time by sacrificial anodes. Coal-tar enamel or asphalt coatings should not be considered adequate for purposes of cathodic protection. Coatings with high dielectric resistance should be used for underground storage tanks and piping. Other important properties of coatings are described in NACE RP-01-69.

## 7.4 Insulation of Exposed Surfaces

**7.4.1** After all piping has been tested and found to be tight (see 10.2), all exposed threads of steel pipe should be coated with an appropriate dielectric material (see 7.3.5). This prevents an electrolytic cell from forming between the galvanized fitting and the threaded area, where the protective coating has been removed. Electrolytic cells can cause corrosion and premature pipe failure. Where a sacrificial-anode system has been installed, nonmetallic (for example, nylon) tank bushings should be installed in tank openings at all points at which product and vent piping are connected to the tank. Separate cathodic protection should be provided for steel piping.

**7.4.2** When tank anchorage is installed (see 6.2.3), anchor straps should be installed so that they do not damage tanks or their coatings and so that the tank is electrically isolated from the straps. Electrical isolation can be accomplished by placing 90-pound roofer's felt or a section of rubber tire between the tank and the anchor straps. Anchor straps should be constructed of a noncorrosive material or of coated steel (galvanized or having a dielectric coating).

## 7.5 Electrical Connections

To ensure electrical continuity between all components of a cathodic protection system, all electrical connections in the system must be secure. For new installations where product is not present, and where safety considerations permit, these connections should be powder-weld connections. If necessary, pressure-type grounding clamps or other clamps designed for this purpose can be used. Electrical work must conform to federal, state, and local codes.

**CAUTION:** If tanks or lines contain or have contained flammable or combustible liquids, powder welds should not be used.



## 7.6 Testing

**7.6.1** Before installation, all equipment should be inspected to ensure that it is undamaged, that electrical continuity has been maintained, and that the equipment is operating properly. After installation but before the system is placed in operation, all equipment should again be inspected and tested for proper operation.

**7.6.2** The rectifiers in impressed-current systems should be checked monthly for proper operation. Annual surveys of structure potentials (see 1.3.32 and 1.3.33), conducted under the supervision of a qualified person, are necessary to ensure continued satisfactory operation. The results of the annual surveys should be

kept with the permanent cathodic protection records for the location.

**7.6.3** Sacrificial-anode systems should be checked for proper operation by a qualified person 6–12 weeks after installation and again 1 year later. If these tests confirm proper operation, subsequent inspection intervals can be extended to 5 years. However, if underground work is performed at a protected site, the sacrificial-anode system should be reinspected 6–12 weeks after the work is completed and again 1 year later before the 5-year inspection intervals are resumed. The inspection procedures used and the data obtained should be clearly recorded and kept with the permanent cathodic protection records for the location.

## SECTION 8—DETECTION OF RELEASES

### 8.1 General

**8.1.1** The prevention of product leaks and spills from storage and dispensing systems is necessary to provide a safe environment and to prevent pollution and should be given the highest priority. This can best be accomplished by properly installing and maintaining tight storage and dispensing systems that are specifically designed and protected for their particular environment.

**8.1.2** If a leak develops, it must be detected promptly to avoid fire, safety, and environmental problems. Early detection also eliminates or reduces product migration and minimizes the costs of corrective action. To assist in the early detection of a release, the following means are available:

- a. Inventory control.
- b. Line leak detectors.
- c. Automatic tank gauging systems.
- d. Observation wells.
- e. Monitoring wells.
- f. Interstitial monitoring.

For further information about release detection, see API Recommended Practices 1621 and 1635.

### 8.2 Inventory Control

**8.2.1** Gauging for inventory control can be accomplished manually or by means of an automatic tank gauging system (see 8.2.3 and 8.4).

**8.2.2** Manual gauging is accomplished by using a gauge stick to measure the product depth in each tank at the open and close of each business day. The stick can

also be used to gauge water bottoms. No special equipment installation is necessary for inventory control by manual gauging.

**8.2.3** Automatic tank gauging systems include both mechanical (float) and electronic (sensor) gauging devices, as described in 8.2.3.1 and 8.2.3.2, respectively.

**8.2.3.1** Mechanical gauging equipment is available for installation in underground tanks. This equipment is float operated and should be installed, operated, and maintained in accordance with the manufacturer's instructions. When mechanical gauging equipment is used, water bottoms in tanks may be measured manually with a gauge stick.

**8.2.3.2** Electronic gauging equipment can provide extremely precise tank level measurements. Many different degrees of sophistication are available. The information can be provided on remote readouts and printouts and can include time and date, product temperature, water level, product level, water volume, product volume, tank leak testing mode (see 8.4), and data from observation and monitoring wells (see 8.5 and 8.6). The use of electronic gauging equipment requires the installation of probes and sensors in the underground tanks, with electrical connections to a remote readout location. Since this equipment is complex, it must be installed, operated, and maintained in exact accordance with the manufacturer's instructions.

### 8.3 Line Leak Detectors

**8.3.1** A variety of leak detectors are available for underground product lines. One type of line leak detector utilizes a pressure-sensing valve, which is usually

installed at the discharge end of a submerged pump. This device senses pressure losses in the line and, when triggered, reduces product flow.

**8.3.2** More sophisticated line leak detectors are available that respond very quickly to a small pressure drop to shut off the electric power to a submerged pump. The use of these systems necessitates installation of pressure sensors in the discharge line immediately after the submerged pump, along with the necessary electrical connections.

## 8.4 Automatic Tank Gauging Systems

Some types of automatic tank gauging systems have a leak testing mode. When the gauging system is set in this mode during a time when the USTS is not in operation, a tank leak test can be conducted. The accuracy of the test is usually related to the period of time the equipment is maintained in the leak testing mode. A test typically takes 4-6 hours; however, this may vary depending on the type of equipment used. The test date, time, and gauging data are usually recorded on a remote printout and can be kept as part of the permanent records for the site.

## 8.5 Observation Wells

**8.5.1** Observation wells can be used to observe secondary containment areas in lined excavations or, where the water table is normally within the excavation or where an impermeable barrier has been installed in the floor of an excavation, to monitor the backfill area around underground tanks. For new installations, an impermeable barrier (see 1.3.10) can be installed in the bottom of the tank excavation if the soil permeability is too high. Observation wells have a casing at least 2 inches in diameter with 0.020-inch slots or an equivalent perforation design. If surface drainage is expected to enter the manhole, the slots should not extend to within 12 inches of grade (see Figure 7).

**8.5.2** When only one tank is to be installed, an observation well should be installed near each end of the tank, inside the tank excavation. When two, three, or four tanks are to be installed in a single excavation, observation wells should be installed at two diagonal corners inside the excavation. When more than four tanks are to be installed in a single excavation, a site-specific hydrogeologic analysis should be performed to determine the correct number and location of observation wells.

**8.5.3** Observation wells should extend to a depth of 24 inches below the bottom of the tank or to the top of the concrete hold-down pad, if one is used for anchoring.

**8.5.4** When an impervious liner is used to provide secondary containment, only one observation well is required. This well should extend to within 6 inches of the bottom of a sump at the lowest point of the containment. If impervious liners are used for underground lines and submerged pumps, one observation well should be installed in the collection sump.

**8.5.5** Observation wells can be equipped with electronic product-monitoring devices. Sensors may be required in each well and must be electrically connected to the readout point. Sensors are available that detect both vapors and liquid. When vapor sensors are used, care should be taken to avoid false alarms resulting from extraneous vapor sources.

**8.5.6** Manual monitoring requires securing a water sample from the well and observing the sample for evidence of petroleum product. The sample can be obtained by using a portable bailer or another device. If no water is present in the well, the vapors in the well can be checked for hydrocarbons by using a portable or stationary monitoring/detection device.

**8.5.7** Observation wells should be identified, sealed, and secured to prevent the accidental or deliberate introduction of product, precipitation, or other materials. The identifying symbol should be a black equilateral triangle on a white background (see Figure 7). One or more of the following actions should be taken to identify new and existing observation wells:

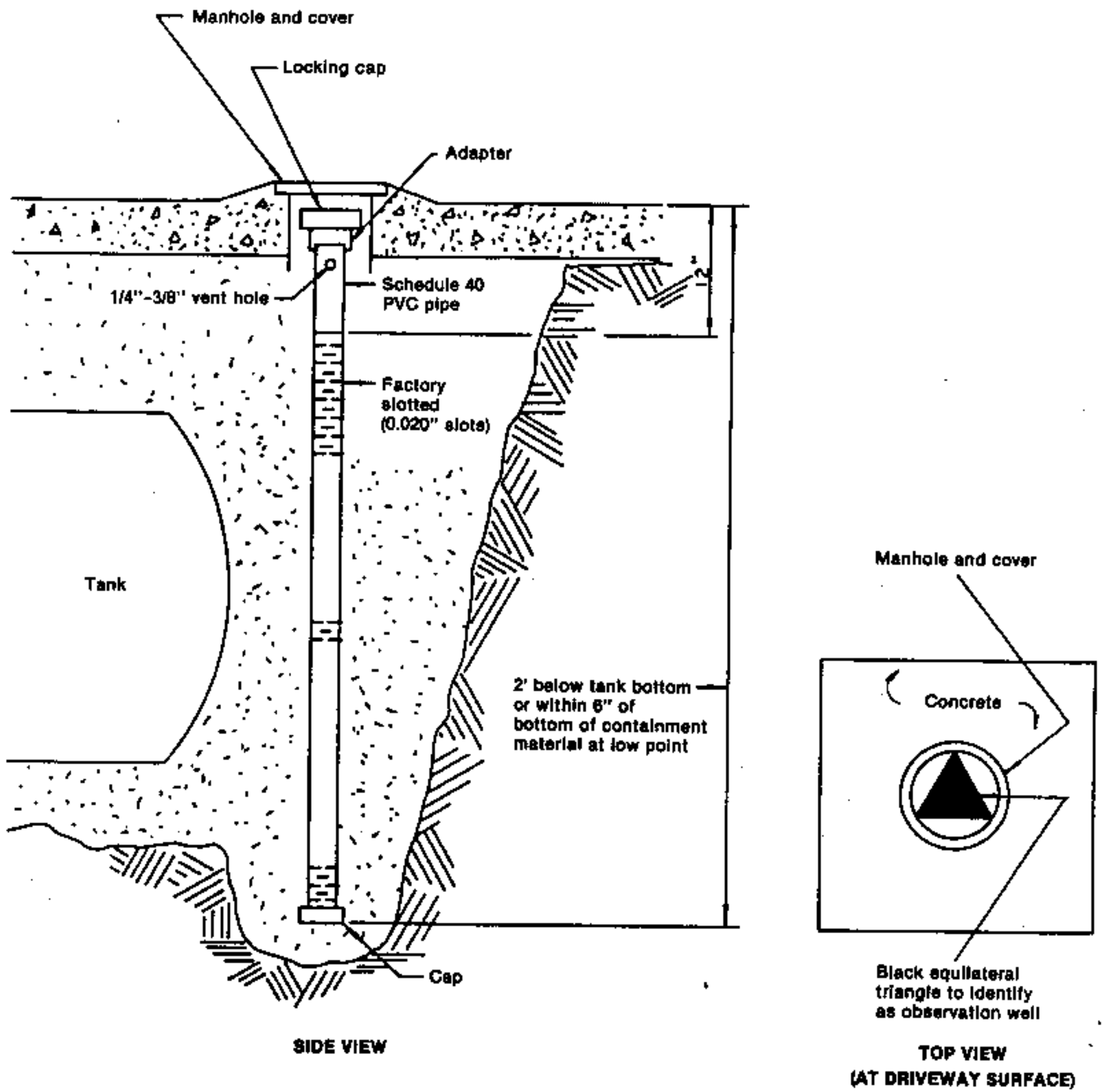
- a. Painting a black equilateral triangle on a white background on the cover and/or cap of the well.
- b. Permanently affixing, to the cover and/or cap of the well, a decal or tag that shows a black equilateral triangle on a white circular background.
- c. Attaching to or casting into the cover and/or cap of the well a raised black equilateral triangular plate on a white circular background.
- d. Installing a triangular well manhole and cover. The cover should be painted black, with its rim or edge painted white.

**8.5.8** In addition to the requirements in 8.5.7, at least one fixed internal component of the well manhole (for example, the cap lock, cap, well casing, or internal manhole surface) should have affixed to it a label (preferably metal or plastic) with the following warning (or a similar one) permanently printed, embossed, or engraved on it:

### OBSERVATION WELL

**WARNING:** Do not place gasoline, petroleum products or other substances in this well. Violators may be subject to civil or criminal penalties.





Note: PVC = polyvinyl chloride.

Figure 7—Typical Observation Well

8.5.9 New and existing observation wells should be secured by taking one or more of the following actions:

- a. Installing a locking cap on the well casing and/or manhole.
- b. Installing a limited-access manhole (see 1.3.14).
- c. Installing a device that renders the well casing incompatible with product fill hoses and nozzles that are likely to be used at the facility.

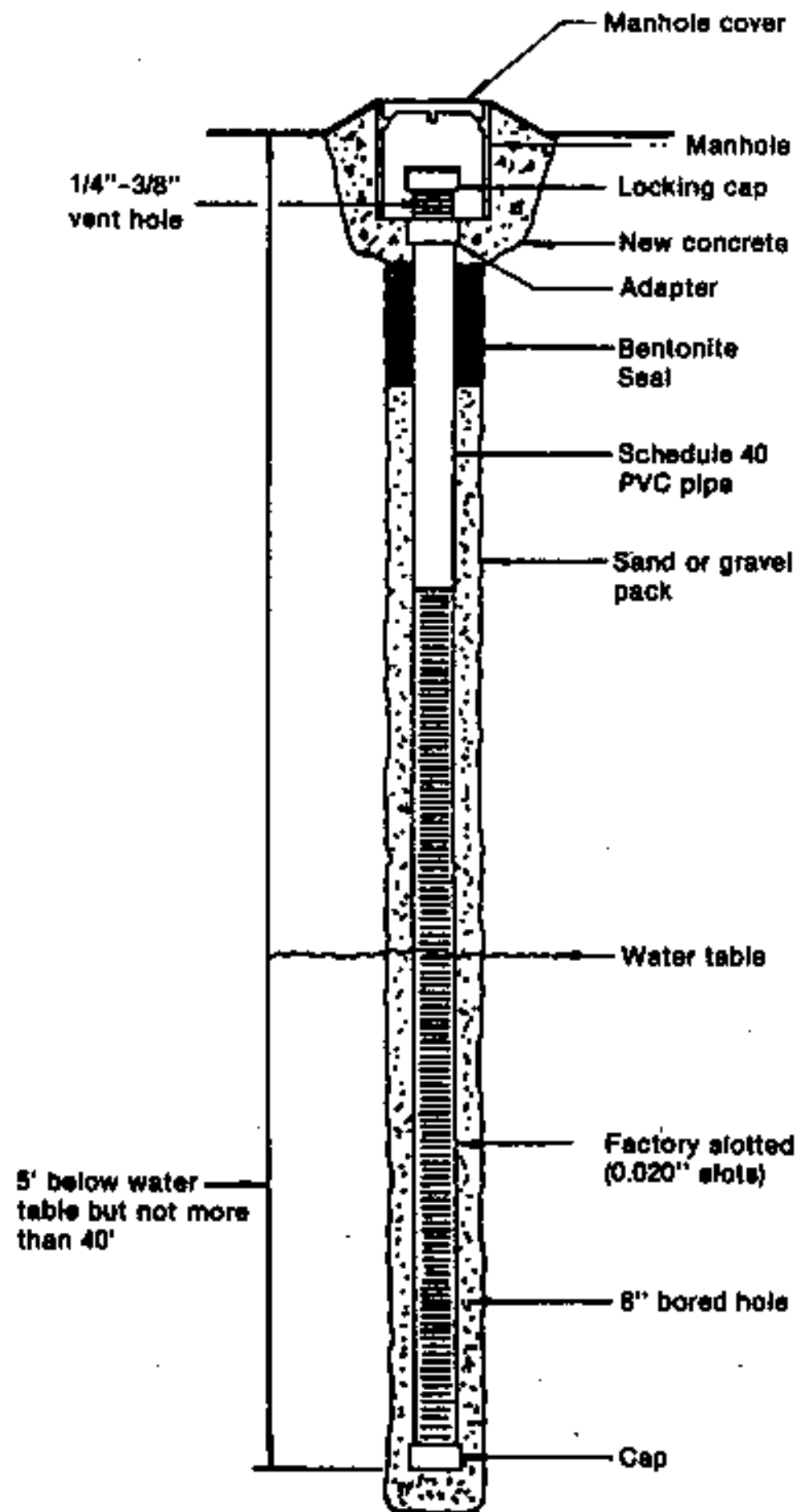
The keys, tools, or codes used to access these security devices should be incompatible with those used to access product fill pipes at the same facility.

## 8.6 Monitoring Wells

Monitoring wells are used to monitor the water table in the area of a USTS. They provide leak detection capabilities equivalent to those of observation wells but should only be used when soil permeability is high and when the normal water table is below the tank excavation but within 40 feet of the ground surface. Monitoring wells should be installed so that the bottom of the well is at least 5 feet below the lowest anticipated water table. Well casings should be at least 2 inches in diameter with 0.020-inch slots (see Figure 8). Monitoring wells are used to detect the presence of petroleum products on the groundwater surface and can be monitored using electronic or manual devices, as described in 8.5.5 and 8.5.6, respectively. The placement of monitoring wells depends on site-specific conditions.

## 8.7 Interstitial Monitoring

The interstice of double-wall tanks and piping can be monitored for product releases either manually or with an automated device. This monitoring can be periodic or continuous, depending on the device used. The manufacturer should be consulted regarding the specific installation requirements of interstitial monitoring devices.



Note: PVC = polyvinyl chloride.

Figure 8—Typical Monitoring Well

## SECTION 9—PIPING

### 9.1 General

Proper installation and testing of the piping system is one of the most important aspects of any USTS installation. Many of the most severe product releases, especially in pressurized pumping systems, have occurred

because of improperly installed piping and pipe joints or because of damage to piping during construction. This applies to both FRP and steel pipe. The authority having jurisdiction should be consulted regarding specifications for installation, testing, and operation of piping systems.

## 9.2 Layout and Design

**9.2.1** A carefully planned, clearly detailed layout should be prepared for each installation. If the layout is properly planned, the length of pipe runs will be minimized, operation will be more efficient, and maintenance will be easier. Piping should be installed in a single trench between the tank area and the island area. Vent lines between the tank area and the building or other structure to which the aboveground vent lines are attached should also be installed in a single trench. Piping across tanks should be minimized, and pipe trenches should run in straight lines with 45- or 90-degree bends. If the location of pipe runs is changed from that shown on the installation drawings, the actual location should be noted on as-built drawings. Photographs of the underground installation should be taken and retained as a part of the permanent records for that location.

**9.2.2** Underground piping from tanks to dispensers should be sized according to the pump manufacturer's recommendations. In determining size, consideration must be given to the length of runs, flow rates, the number and size of pumps, and the number of dispensers to be served. In any case, piping should not have an inside diameter of less than 2 inches.

**9.2.3** Underground product lines and vapor return lines (if required) should have a uniform slope of not less than 1/8 inch per foot toward the tank. The historical depth of frost (if any) should be taken into account when the burial depth of the piping is determined. Product lines should be at least 12 inches below the finished surface (see 10.3.1). The pipe manufacturer's instructions should be followed if burial at a greater depth is required. Traps or sags should be avoided in all piping.

**9.2.4** It is occasionally necessary or advisable to install more than one storage tank for a given product. Such tanks may be interconnected by means of a siphon connection. A siphon will provide reliable service only if care is taken to ensure that all joints in the siphon manifold are tight. Although not recommended, if it is necessary to connect tanks of different diameters at a new installation by means of siphons, both the bottoms of all the tanks and the ends of the suction stub piping in each tank should be at the same elevation (see Figures 3 and 4). In addition, care should be taken to ensure that the vent line leaving the smaller diameter tank rises vertically to a point higher than the top of the larger tank before the horizontal section of vent piping is installed. Remote pumps are available with a siphoning attachment that can be connected to a siphon manifold. This permits one pump to draw the contents from two or

more interconnected tanks (see Figure 4). The manufacturer's installation instructions should be followed. Siphon piping should be of the same diameter as the suction and/or delivery lines to the dispensers.

**9.2.5** The vent piping for all tanks should be adequately sized. This is necessary to prevent excessive pressure from building up while the tank is being filled and to prevent vapor or liquid from blowing back at the fill opening when the unloading hose is disconnected. The maximum fill rate can be limited by the diameter of the vent line. Vents that are 2 inches in diameter (for up to 150 feet in length) should be adequate for flow rates incurred using 4-inch delivery equipment (see NFPA 30).

**9.2.6** Vent piping should be at least 12 inches below the finished surface (or at least 4 inches in no-load areas), measured from the point where the piping rises vertically, and should slope uniformly toward the tank. The pipe manufacturer's instructions should be followed if a greater burial depth is recommended. The piping should slope no less than 1/8 inch per foot, and the piping should be laid to avoid sags or traps in the line, in which liquid could collect.

**9.2.7** Aboveground vent piping should be Schedule 40 galvanized steel and should be located, or protected and anchored, to prevent damage from traffic and other sources. FRP piping should not be used aboveground. Vents may be either freestanding with a vertical support or attached to a building (see Figure 9). Vent outlets should be located to prevent flammable vapors from entering confined areas and building air-conditioning and/or ventilation intakes or from reaching potential ignition sources. Vent outlets must discharge upward, and the discharge point must be no less than 12 feet above the adjacent ground or, if the vent is attached to a building, no less than 2 feet above the roof at the point of attachment. Where required by local ordinances or special conditions, vent caps should be installed.

## 9.3 Steel Piping

**9.3.1** Underground steel piping should be Schedule 40 galvanized steel. As a minimum, couplings and fittings should be 150-pound malleable iron. A thread sealant certified for petroleum service should be used for all fittings.

**9.3.2** Breakage of underground piping and vent lines, as well as loosening of pipe fittings, which can result in product leaks, can be minimized by the use of flexible joints (see 1.3.8). Flexible joints should be installed in lines at points where the piping connects with the under-

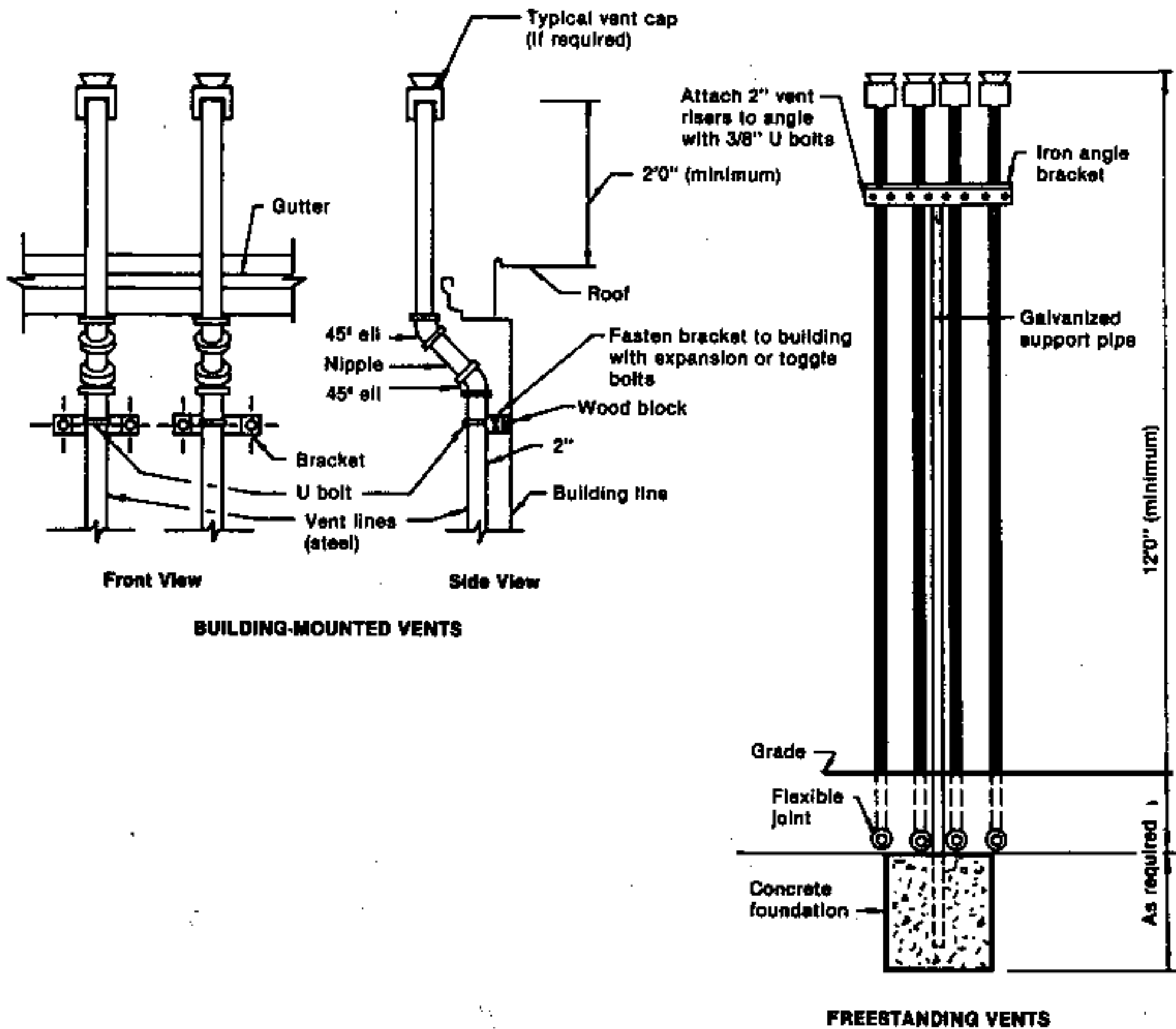


Figure 9—Typical Vent Details

ground tanks and where the piping ends at the pump islands and vent risers (see Figures 10 and 11).

#### 9.4 Fiberglass-Reinforced Plastic Piping

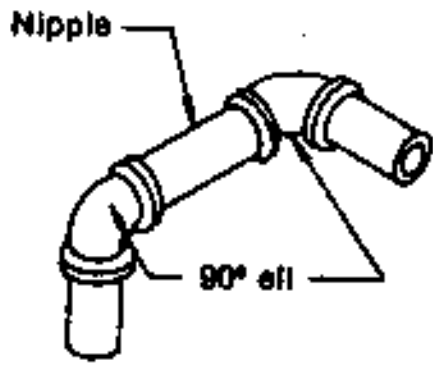
9.4.1 Any FRP pipe used in an underground petroleum installation should be UL approved.

**CAUTION:** When FRP pipe is used, it is extremely important that it be installed in exact accordance with the manufacturer's instructions.

9.4.2 FRP piping, which is inherently flexible, can be used to create its own flexible joint if at least 4 feet of

straight run is provided between any directional changes of more than 30 degrees (see Figure 10). Commercially available flexible joints that are certified for petroleum service, as described in 9.3.2, may be used under dispensers and suction pumps and at submerged pumps and tanks in lieu of the 4-foot straight run mentioned above.

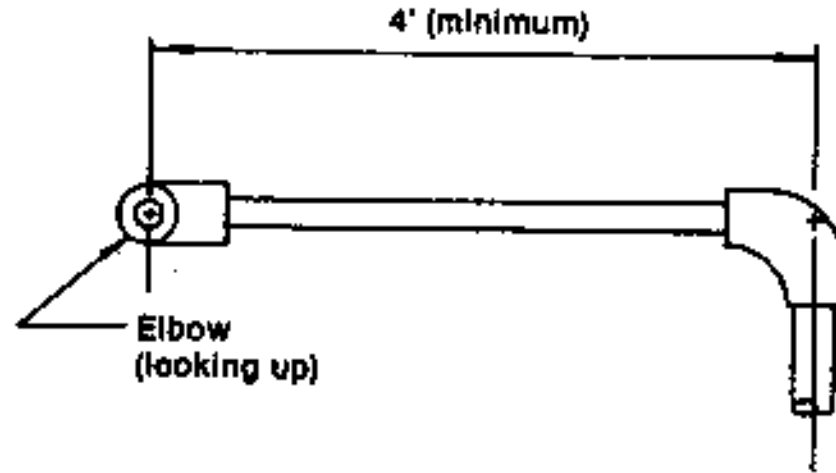
9.4.3 Pipe joints must be straight, not cocked, and must be fully seated, not backed out. The joint adhesive used must conform to the manufacturer's recommendations for underground petroleum service and must not



SWING JOINT



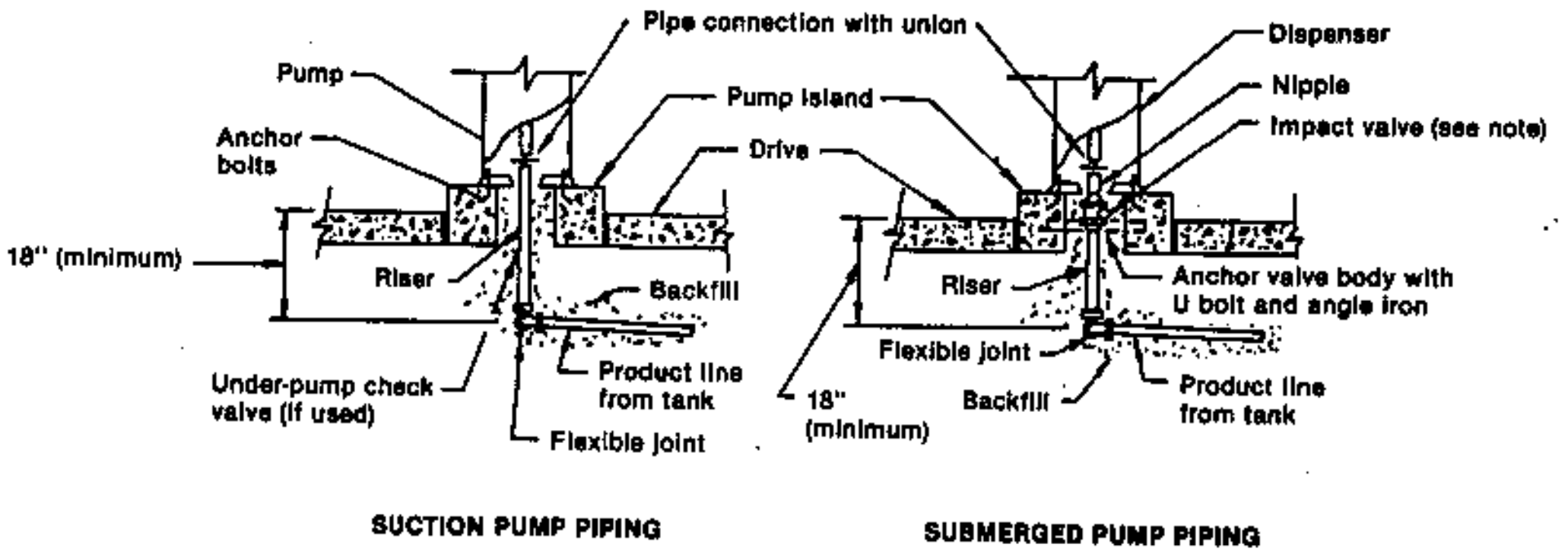
FLEXIBLE CONNECTOR



FLEXIBLE FRP PIPE JOINT

Note: There must be a minimum of 4 feet of straight pipe between any directional changes of more than 30 degrees.

Figure 10—Typical Flexible Joints for Piping



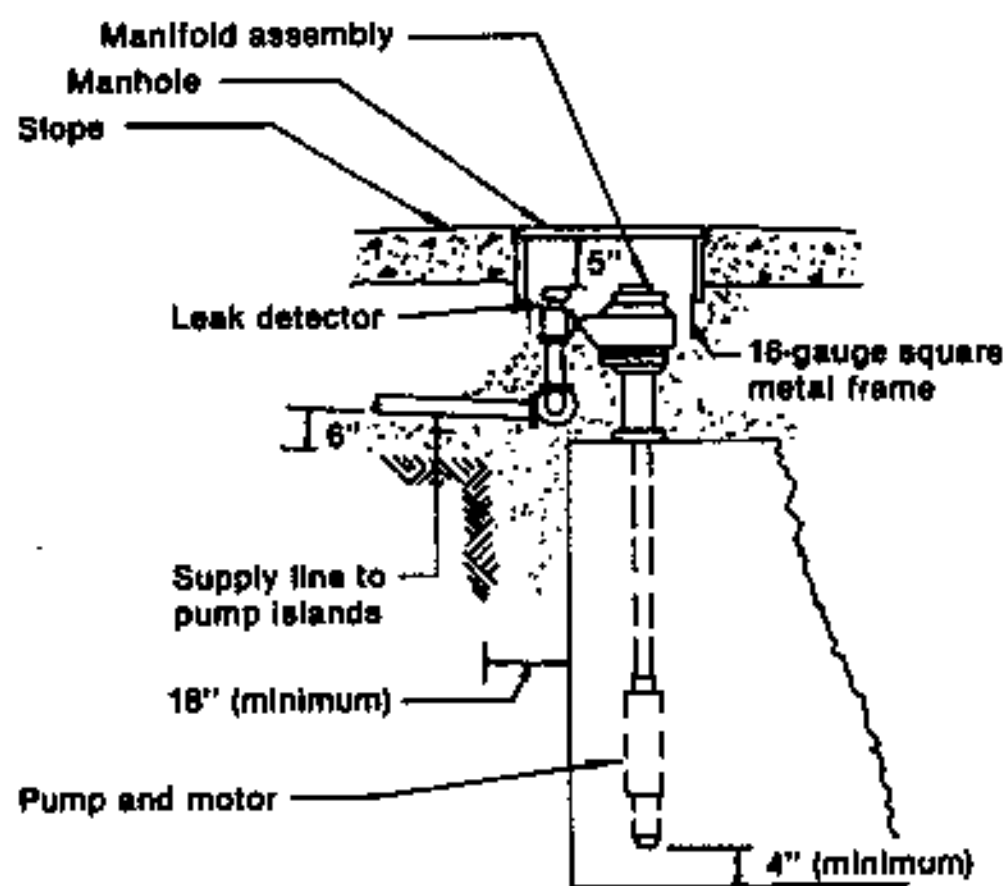
Note: For the impact valve to function properly, it must be installed so that the shear section is level with the top of the island pedestal.

Figure 11—Typical Island Piping: Dispenser/Suction System Without Vapor Recovery

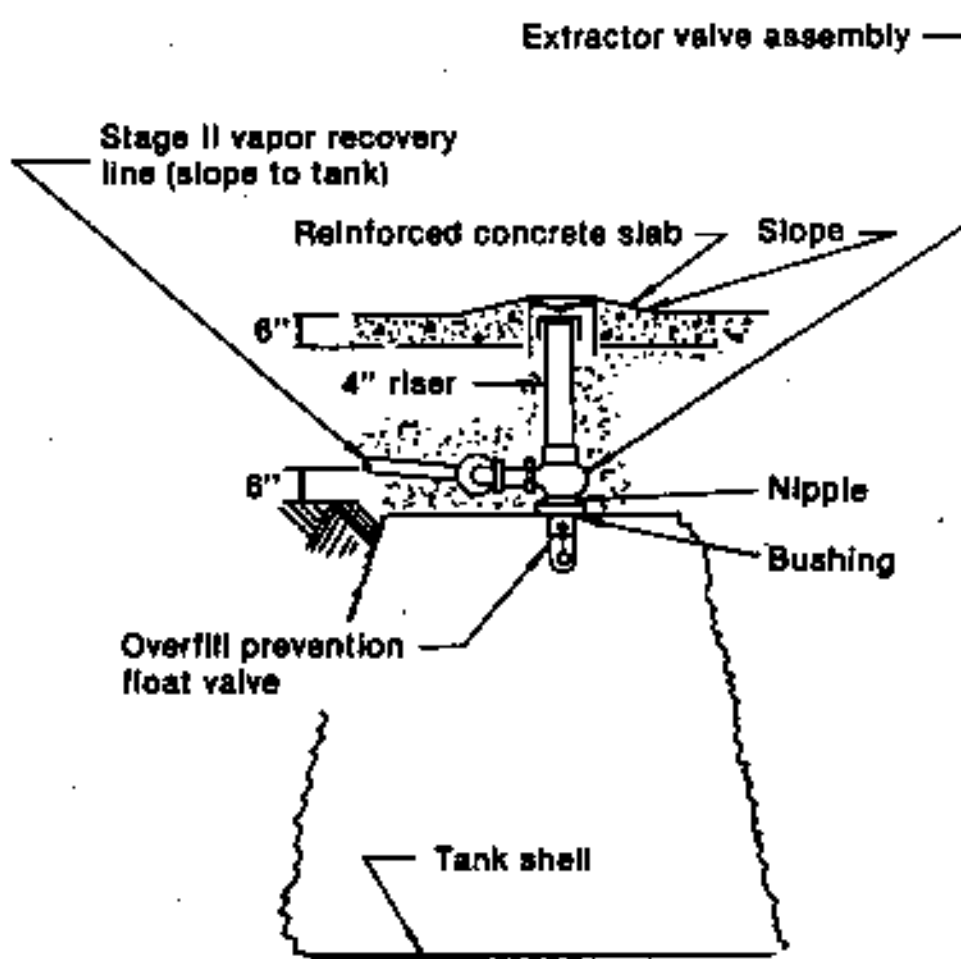
be used at temperatures below the recommended minimums. If the temperature is below the recommended minimum, the manufacturer's instructions should be followed for providing heat to the joint to ensure a complete cure.

### 9.5 Overfill Protection and Containment of Fill-Pipe Spills

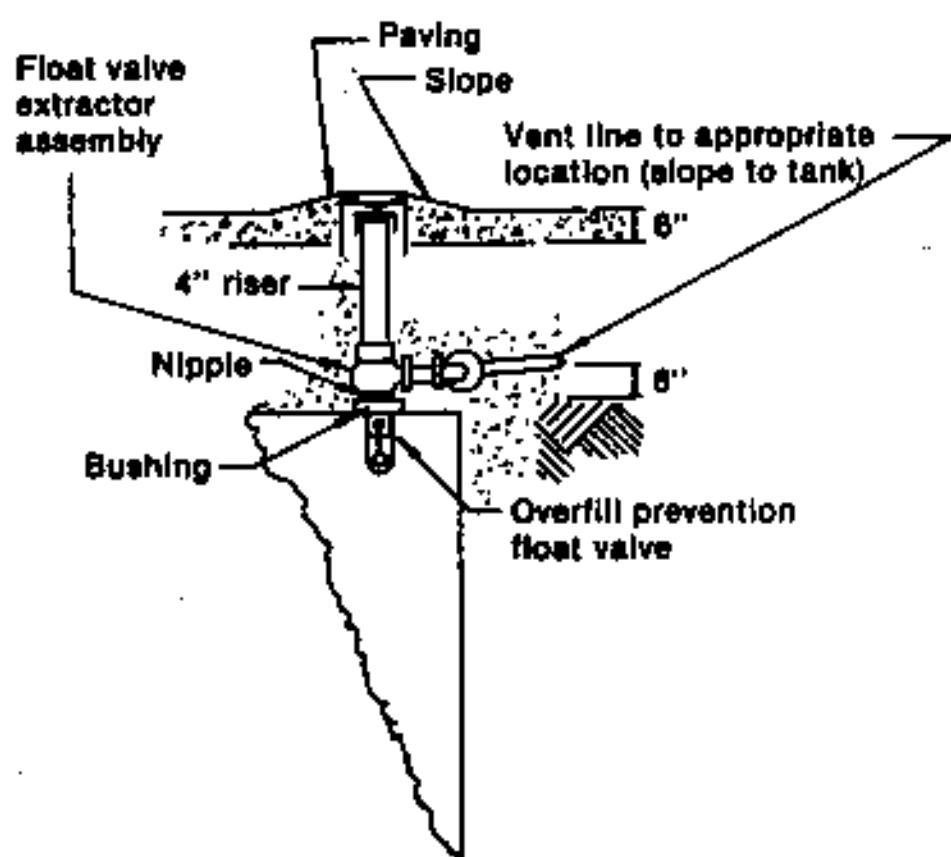
9.5.1 Spills, drips, and overfills that occur during transfer operations from the delivery truck to the under-



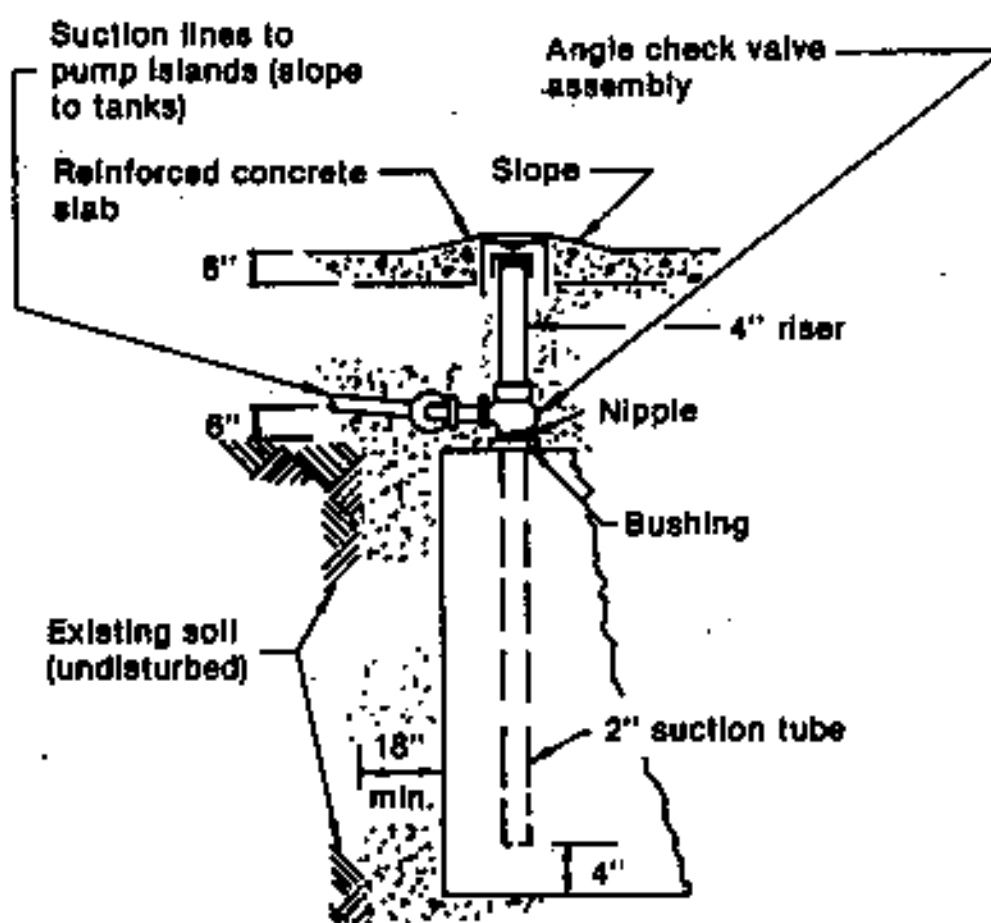
**SUBMERGED PUMP**



**VAPOR RECOVERY LINE TO MANIFOLD OR ISLAND (WITH OVERFILL PREVENTION)**



**VENT LINE (WITH SWING JOINT AND OVERFILL PROTECTION)**



**SUCTION STUB (WITH ANGLE CHECK VALVE)**

Figure 12—Typical Tank Piping Details

ground tank should be prevented or contained. Overfill problems can be reduced by installing ball check valves or float valves in the vent line and Stage I and Stage II vapor recovery lines where the vent lines leave the underground tank (see Figure 12).

**9.5.2** To contain small overfills that may still occur, a spill containment manhole should be installed on the fill pipe of the underground tank (see Figure 13). Containment manholes can be purchased with a drain that

routes any spilled product back into the underground tank.

**9.5.3** The overfill protection described in 9.5.1 and 9.5.2 is necessary even if partial or full secondary containment is installed. Without this protection, spilled product may get into the backfill and may reach the observation well of the secondary containment and be interpreted as a suspect leak. Secondary containment is discussed in 6.3 and is illustrated in Figure 6.

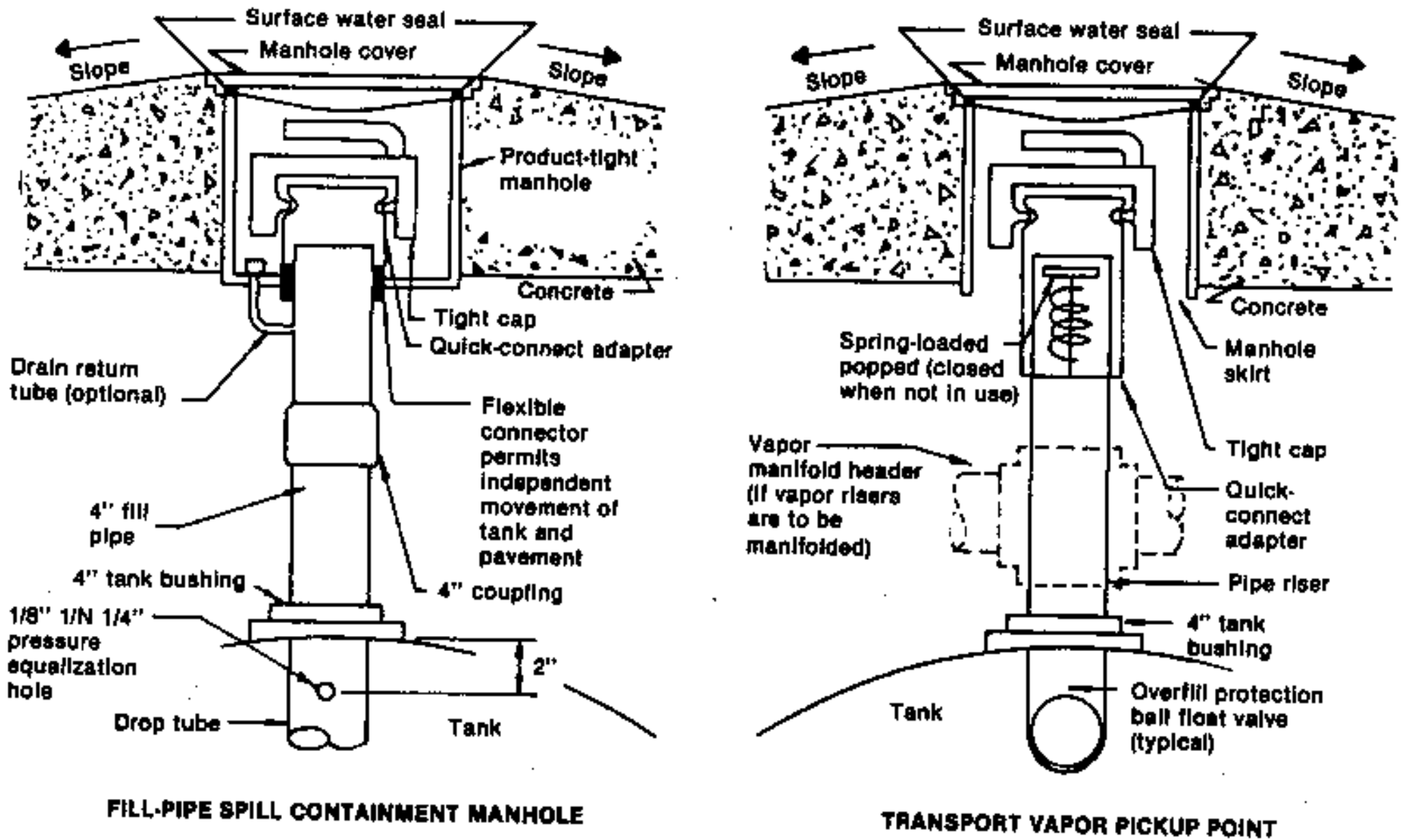


Figure 13—Typical Piping Details: Fill-Pipe Spill Containment Manhole and Transport Vapor-Pickup Point

## SECTION 10—BACKFILLING

### 10.1 General

Backfilling operations are an important aspect of USTS installation and should be continuously supervised by a qualified person to ensure that only specified materials and installation methods are used by the contractor. Excavated material is not generally suitable as backfill for underground tanks and lines. Unless the excavated material is specifically examined and approved

for use by the authority having jurisdiction, it should be removed from the site.

### 10.2 Pipe Tightness Test

Before backfilling, piping should be isolated from the tanks and subjected to a pipe tightness test (see 1.3.22). Other testing methods may be substituted if approved by the authority having jurisdiction.



## 10.3 Placement of Materials and Compaction of Backfill

### 10.3.1 UNDERGROUND LINES

Before any underground lines are installed, the trench for such piping should receive a bed of well-compacted backfill at least 6 inches deep, as recommended by the piping manufacturer. The bed must be free from ice, snow, debris, and organic material. All trenches should be wide enough to permit at least one pipe diameter between steel lines, two pipe diameters between FRP lines, and 6 inches of backfill between all underground lines (whether steel or FRP) and the sides and floor of the trench. A cover of at least 6 inches of well-compacted backfill is recommended.

### 10.3.2 UNDERGROUND TANKS

#### 10.3.2.1 Steel and Fiberglass-Clad Steel Tanks

Backfill for steel and fiberglass-clad steel tanks should be well compacted, as recommended by the manufacturer, and must be free from ice, snow, debris, and organic material, which adversely affect compaction and may damage the tank or its coating. The backfill bed for steel tanks should be 12 inches deep, with or without a hold-down pad. A minimum of 12 inches of backfill (or the amount required by the manufacturer) should be placed between all tanks and at the ends and sides of all tanks. All bedding material, backfill around the tanks, and covering over the tanks (see 5.3.2) should be of the same material.

#### 10.3.2.2 Fiberglass-Reinforced Plastic Tanks

Backfill for FRP tanks must be free from ice, snow, debris, and organic material, which adversely affect compaction and may damage the tank. All backfill material should be in strict accordance with the manufacturer's specifications. Such backfill is generally pea gravel or crushed stone that meets the requirements of ASTM C 33. The backfill bed for FRP tanks should be 12 inches deep on top of the hold-down pad or the bottom of the excavation. If no hold-down pad is used, 18 inches of backfill should be placed between all tanks. All bedding material, backfill around the tanks, and covering over the tanks (see 5.3.2) should be of the same material.

#### 10.3.2.3 Compaction of Backfill for All Tanks

It is especially important that the bottom quadrant of all tanks (both FRP and steel) be evenly and completely supported. The backfill material should be carefully placed along the bottom and under the sides and end caps or heads of the tanks by manual shoveling and tamping. The backfilling may then be completed in 12-inch lifts, uniformly placed around the tanks. Care must be taken to avoid damage to the tanks or their coating.

## 10.4 Grading and Paving

**CAUTION:** Extreme care should be taken during final grading operations to avoid damage to piping and equipment by heavy tractor blades and cleats. Equal care should be taken when stakes are driven for grading or paving, to avoid damage to piping by a stake being driven into or against the piping. *Puncturing an installed system can lead to the migration of flammable liquids or vapors to an ignition source, resulting in an explosion on the site or in an adjacent area.* Mistakes made during grading and paving are among the most common causes of installation-related failure of USTs.

## 10.5 Post-Backfill Inspection of Fiberglass-Reinforced Plastic Tanks

After backfilling has been completed but before concrete or asphalt paving has been installed, the inside diameter of FRP tanks should be measured and compared with the inside diameter measured as recommended in 3.5.1.3, to ensure that tank deformation resulting from backfilling does not exceed the manufacturer's specifications. The diameter measurements should be retained permanently for future reference.

**CAUTION:** Tanks should not be entered for any purpose unless the proper safety precautions, as outlined in API Publication 2217, are taken.

## 10.6 Final Testing

- Conduct precision test (see 1.3.23) of all tanks and piping after all paving over the tanks and piping has been completed and before the system is placed in operation.
- Operationally test all other equipment, including impact (shear) valves, and leak detector alarms.



## SECTION 11—OTHER EQUIPMENT

### 11.1 Pumping Systems

#### 11.1.1 GENERAL

Although this recommended practice is intended primarily as a guide for installing underground tanks and piping, consideration should be also be given to the type of pumping system to be used. Such consideration will in turn determine aspects of piping design and leak detection.

#### 11.1.2 SUCTION PUMPING SYSTEMS

**11.1.2.1** A suction pumping system (see 1.3.34) usually consists of a pump in each dispenser, with individual product suction lines running from each pump to the underground storage tank.

**11.1.2.2** When a suction pumping system is used, the height to which the pumps can lift the product is a critical factor. The tank diameter and the length of product piping between the tank and the pump should therefore be kept to a minimum. This is especially important in warmer climates and at higher altitudes. The pump manufacturer can provide assistance with these design requirements.

#### 11.1.3 REMOTE PUMPING SYSTEMS

**11.1.3.1** A remote or submerged pumping system (see 1.3.28) is located in or above the underground storage tank (see Figure 14). This permits the use of a single product line from each product pump to the dispensers on the pump islands. This type of system permits the use of more dispensers for each product and a reduction in the quantity of buried piping. An impact valve, level with the top of the island, must be installed at each dispenser (see Figures 11 and 15; see also NFPA 30A).

**11.1.3.2** With remote pumping systems, the delivery of product does not depend on the depth of the tank or (within certain limits) on the length of the product piping.

#### 11.1.4 OTHER FACTORS

**11.1.4.1** Other factors to be considered in the selection and installation of pumps are described in 11.1.4.2 through 11.1.4.7.

**11.1.4.2** Pump seals and materials of construction should be designed for and compatible with the liquids to be handled. The authority having jurisdiction and the

manufacturer should be consulted for additional requirements.

**11.1.4.3** Suction stubs in underground tanks for suction pumping systems should have the same diameter as do the product lines they serve. Suction stubs and remote pumps should extend to within 4 inches of the bottom of the tank or to the level specified by the manufacturer.

**11.1.4.4** Where suction pumps are used, a double poppet valve should be installed under each pump, or an angle check valve should be installed at the tank for each product line (see Figure 16). If the fitting is to be installed under concrete, an extractor angle-valve manhole or concrete breakout can be used.

**11.1.4.5** For remote pumping systems, a line leak detector should be installed that has the capability of detecting a leak and restricting product flow (so it is evident that a potential problem exists) or shutting down the pumping system (see 8.3).

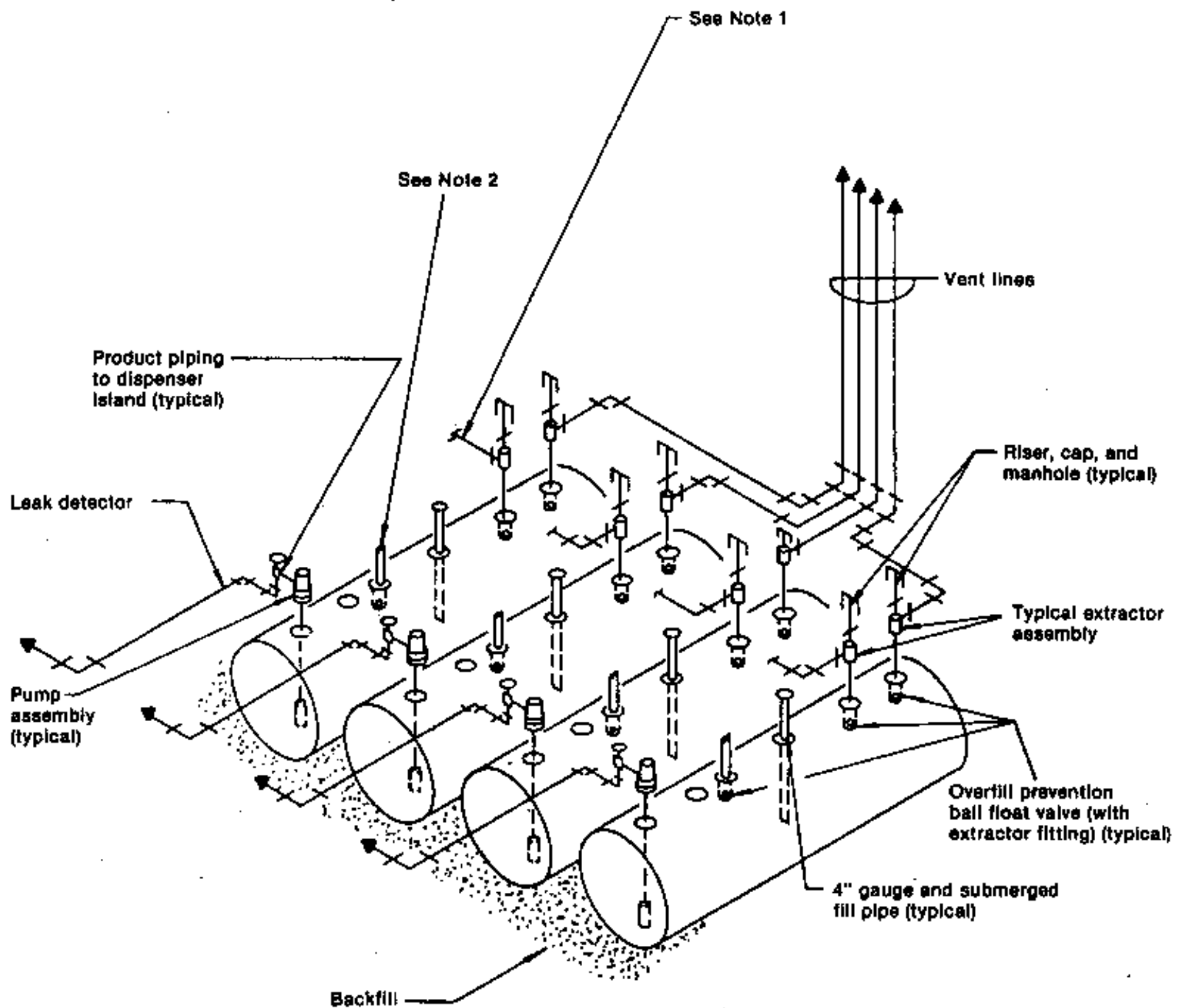
**11.1.4.6** Pumping systems should be equipped with clearly identified and easily accessible electrical switches or circuit breakers. The switches or breakers should be located away from dispensers and pumps and should permit the immediate shutdown of all dispensing devices in the event of an emergency. The authority having jurisdiction should be consulted for any additional requirements.

**11.1.4.7** Dispensers should meet the requirements of UL 87 and should bear the UL label.

### 11.2 Tank Fittings

**11.2.1** Tanks should be equipped with the desired number and size of tank openings. The tank manufacturer's specifications and drawings must be checked to determine the types (steel or FRP), sizes, and capacities that are available.

**11.2.2** Tank openings should be 4 inches in diameter, and most tank openings are of this size. Fill pipes, fill caps, and fill tubes are also normally 4 inches in diameter. Submersible pumps designed with the capacity to meet the normal layout and operation requirements of service stations are built to fit 4-inch tank openings. If greater capacity is needed, larger pumps and tank openings may be required.



**Notes:**

1. If required, a Stage II vapor recovery line should run to the vapor collection manifold and then to the dispenser islands. If the vapor recovery system is not manifolded, each line should go to the dispenser islands. A float valve, extractor, riser, cap, and manhole should be included for each tank. (The arrangement shown is typical.)
2. If required, a Stage I vapor recovery riser should run to the vapor collection manifold, with one surface pickup point. If the vapor recovery system is not manifolded, each riser should go to a separate surface pickup point. Each riser pipe should be connected to a ball float valve. (The arrangement shown is typical.)
3. See Figure 12 for details of tank piping.

**Figure 14—Typical Remote Pumping System (Shown With Stage I and Stage II Vapor Recovery)**

**11.2.3** Double-tapped bushings are used to reduce the size of the tank opening so that appropriate fittings can be attached and connecting pipes inside and outside of the tank can be installed.

**11.2.4** Nonmetallic tanks are fitted with threaded openings to receive the double-tapped bushings described in 11.2.3, as well as plugs.

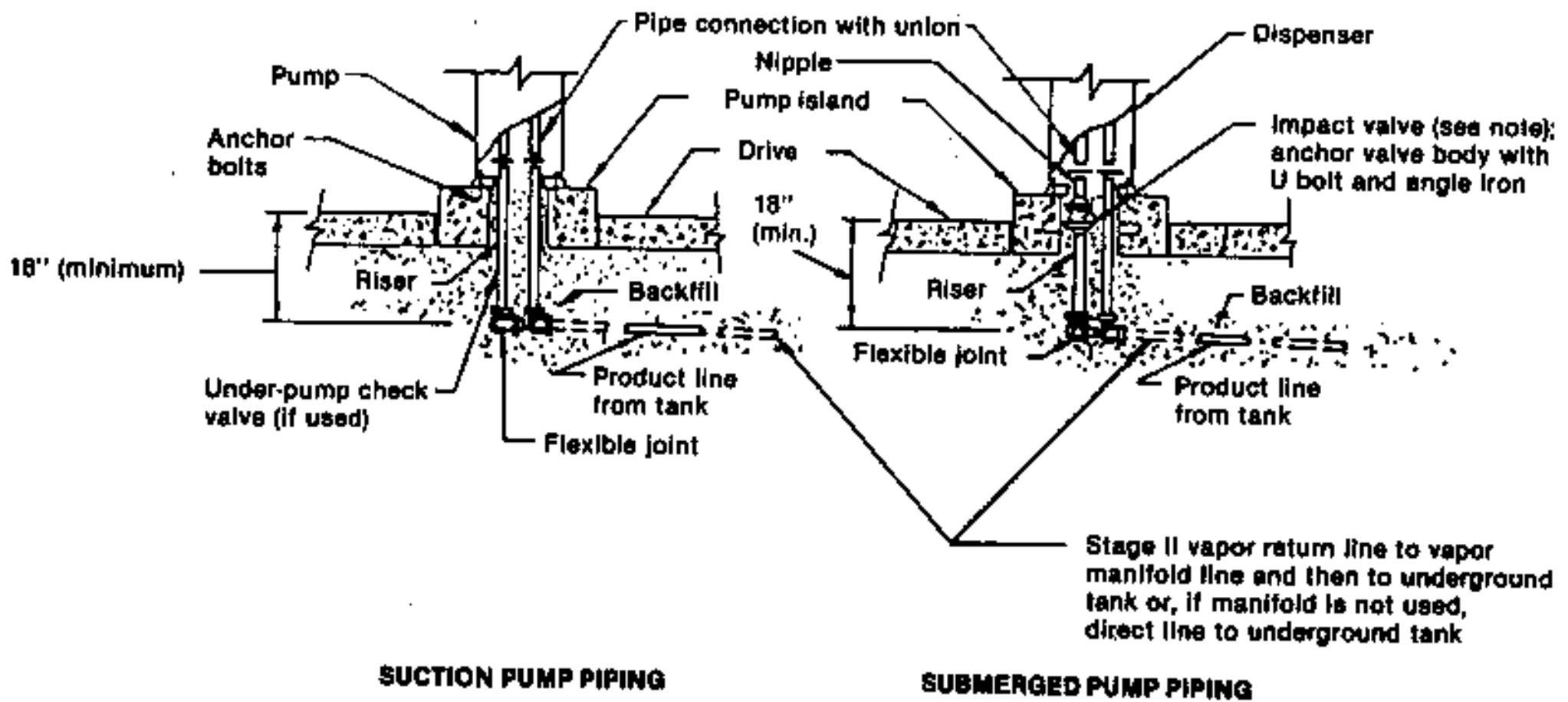


Figure 15—Typical Island Piping: Dispenser/Suction System With Stage II Vapor Recovery

**11.2.5** Fill pipes may be located at any opening in the tank. Reinforced plates should be installed under fill and gauge openings in all tanks.

**11.2.6** All fill connections should be of a tight-fill design. A fill tube should be inserted at the fill opening and should extend to within 6 inches of the tank bottom. The use of tight fill connections and fill tubes will increase the rate of product flow during filling and decrease turbulence and product vapor loss. If the fill connection is to be used for gauging, a 1/8-inch hole should be installed in the drop tube immediately inside the tank to allow for pressure equalization, which will permit accurate gauging.

**11.2.7** A liquid-tight fill cap, equipped with a lock, should be installed and should be used in conjunction with a manhole ring and cover.

### 11.3 Identification of Driveway Manholes

The product being handled and the size of the tank should be marked on the fill assembly or manhole cover. The product can be identified by using a color code (see API Recommended Practice 1637) or by stamping or otherwise applying the product name to the fixed portion of the fill assembly or by both means.

## SECTION 12—VAPOR RECOVERY

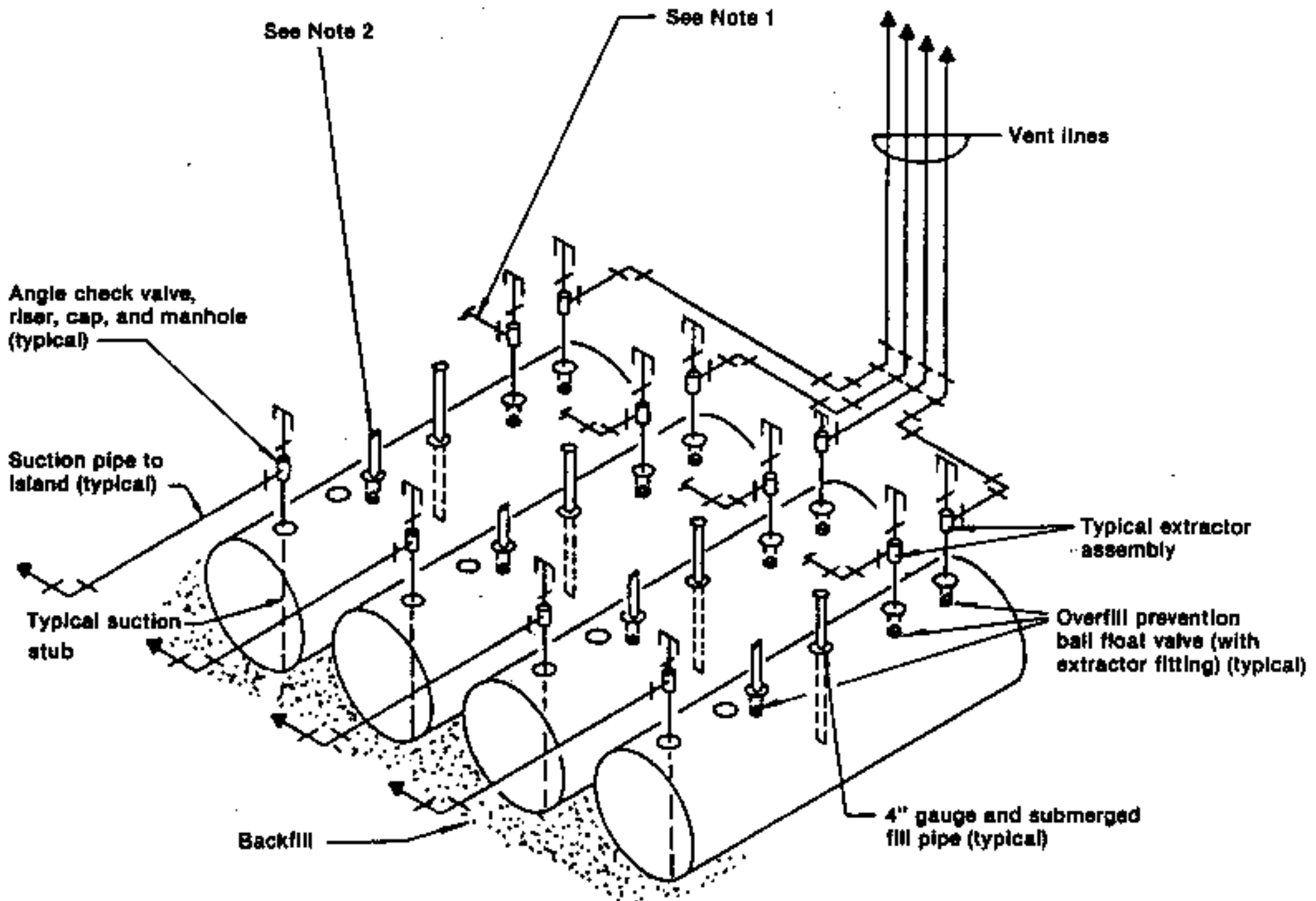
### 12.1 General

**12.1.1** The use of vapor recovery systems is required in some areas of the United States. The purpose of vapor recovery is to reduce vapor emissions to the atmosphere. The authority having jurisdiction should be consulted for specific requirements.

**12.1.2** Vapor recovery is sometimes required during transfer operations, namely, the unloading of a transport truck cargo into underground storage tanks. This type of vapor recovery is referred to as Stage I

vapor recovery (see Figures 4 and 16). Vapor recovery may also be required during the delivery of gasoline into the fuel tank of a motor vehicle. This type of vapor recovery is referred to as Stage II vapor recovery (see Figure 15). Different systems or variations of systems can be used to accomplish both Stage I and Stage II vapor recovery. The primary systems used are of the following types:

- a. Balance systems.
- b. Vapor processing systems.



**Notes:**

1. If required, a Stage II vapor recovery line should run to the vapor collection manifold and then to the dispenser islands. If the vapor recovery system is not manifolded, each line should go to the dispenser islands. A float valve, extractor, riser, cap, and manhole should be included for each tank. (The arrangement shown is typical.)
2. If required, a Stage I vapor recovery riser should run to the vapor collection manifold, with one surface pickup point. If the vapor recovery system is not manifolded, each riser should go to a separate surface pickup point. Each riser pipe should be connected to a ball float valve. (The arrangement shown is typical.)
3. See Figure 12 for details of tank piping.

Figure 16—Typical Suction-Pump Tank System (Shown With Stage I and Stage II Vapor Recovery)

## 12.2 Balance Systems

### 12.2.1 GENERAL

The most commonly used method of vapor recovery is the balance system. A balance system will meet the efficiency requirements of most regulations. A balance system simply provides for the gasoline vapors in the receiving tank to be returned via piping and/or hoses to the delivering tank. A balance system can be used for both Stage I and Stage II vapor recovery.

### 12.2.2 STAGE I VAPOR RECOVERY

#### 12.2.2.1 General

Three of the most common designs for Stage I vapor recovery balance systems are as follows:

- a. Two-point balance system.
- b. Single-point manifold balance system.
- c. Coaxial balance system.

### 12.2.2.2 Two-Point Balance System

**12.2.2.2.1** The two-point balance system for vapor recovery during transport deliveries to underground tanks is provided by installing a vapor pickup point (a vapor return riser) in each underground tank that is required to have Stage I vapor recovery.

**12.2.2.2.2** The vapor pickup uses one of the 4-inch openings in the underground tank (see Figure 13). For ease in hose handling, this is usually the opening immediately next to the fill-pipe opening. A riser pipe with an inside diameter of 3 or 4 inches, ending in a manhole similar to a fill manhole, is extended from the tank to the surface. A vapor pickup adapter is installed on top of the riser pipe, to provide a quick-disconnect connection for the transport's vapor pickup hose. The vapor pickup adapter must have a spring-loaded poppet valve that is closed when the vapor pickup hose is not connected.

**12.2.2.2.3** As with the other Stage I balance systems described in 12.2.2.3 and 12.2.2.4, when the two-point system is in operation, vapors are automatically returned to the transport when the product is delivered to the underground tank. The small vacuum created in the transport and the ease of movement through a larger (3- or 4-inch) pipe cause the vent to be bypassed.

**12.2.2.2.4** With both the two-point system and the coaxial system (see 12.2.2.4), if more than one tank is used to store a single product and the tanks are manifolded for product leveling, a vapor manifold should be provided for vapor transfer between the tanks.

**12.2.2.2.5** A variation of the two-point system uses a special fill-and-drop-tube assembly, which combines a vapor return tube with the product drop tube in one riser. This special riser pipe has a Y fitting that routes the product and vapor conductors to separate hose connection points in the driveway surface.

Note: This vapor recovery configuration cannot utilize a float valve to prevent overfills.

### 12.2.2.3 Single-Point Manifold Balance System

The single-point manifold balance system is very similar to the two-point balance system. The primary difference is that in the single-point manifold system, the vapor pickup riser in each tank is manifolded into a vapor manifold header from which a single (3- or 4-inch) riser is brought to the surface, where the same adapter and poppet are installed within a manhole (see Figure 13).

### 12.2.2.4 Coaxial Balance System

The coaxial balance system uses one opening in each tank. This opening accommodates both a fill tube and a vapor return from the tank to the surface in concentric pipes. At the surface, a special adapter is installed within a manhole. A special tight-fill delivery nozzle with combination product and vapor conductors must be used with the adapter on the top of the riser. Both the transport-truck fill hose and the vapor return hose are connected to this special coaxial nozzle.

Note: This vapor recovery configuration cannot utilize a float valve to prevent overfills.

## 12.2.3 STAGE II VAPOR RECOVERY

**12.2.3.1** Balance system vapor recovery can be provided during delivery from an underground tank to a vehicle fuel tank by installing a vapor return line from a special dispensing nozzle (which provides a seal at the fuel tank opening) to the underground tank. A separate vapor return line should be provided for each product, unless the tank vapor spaces are manifolded as described in 12.2.2.3. If the tank vapor spaces for all gasoline products are manifolded to a single vapor manifold header for Stage I vapor recovery, the vapor return line from each dispensing nozzle may also be manifolded to a single, larger diameter vapor return line from the islands to the manifolded tanks. This vapor return line from under the dispenser to the underground tanks can be of the same material as the underground lines that deliver product to the dispenser.

**12.2.3.2** All aboveground piping must be steel. The minimum inside diameter for vapor return lines is 2 inches.

**12.2.3.3** The vapor return line piping in the dispenser should be continued to the outside of the dispenser, where a hose connection can be made. A hose must then be connected from this vapor return pipe to the special vapor recovery dispensing nozzle.

**12.2.3.4** The system design must provide a continuous slope from the dispenser or island to the underground tanks. Any sags will provide pockets in which condensed vapor or product may collect and block the vapor return line.

**12.2.3.5** As with the Stage I systems, when a Stage II system is in operation, vapors are automatically returned to the underground tank when product is dispensed into the vehicle fuel tank.

### 12.3 Vapor Processing Systems

The term *vapor processing* covers other methods of vapor recovery, such as flaring or burning and condensation by refrigeration or compression. Information about vapor processing systems can be obtained from manufacturers of petroleum equipment.

### 12.4 Equipment

Petroleum equipment manufacturers and suppliers can furnish all of the special equipment required for Stage I and Stage II vapor recovery.

### 12.5 System Design

If regulations require the installation of either Stage I or Stage II vapor recovery, professional assistance should be obtained in designing the system.