Recommended Practices for the Closure of Underground Storage Tanks and Shop-Fabricated Aboveground Storage Tanks
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Recommended Practices for the Closure of Underground Storage Tanks and Shop-Fabricated Aboveground Storage Tanks
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- PEI/RP100, *Recommended Practices for Installation of Underground Liquid Storage Systems*
- PEI/RP400, *Recommended Procedure for Testing Electrical Continuity of Fuel Dispensing Hanging Hardware*
- PEI/RP500, *Recommended Practices for Inspection and Maintenance of Motor Fuel Dispensing Equipment*
- PEI/RP600, *Recommended Practices for Overfill Prevention for Shop-Fabricated Aboveground Tanks*
- PEI/RP800, *Recommended Practices for Installation of Bulk Storage Plants*
- PEI/RP1000, *Recommended Practices for the Installation of Marina Fueling Systems*
- PEI/RP1100, *Recommended Practices for the Storage and Dispensing of Diesel Exhaust Fluid (DEF)*
FOREWORD

These Recommended Practices for the Closure of Underground Storage Tanks and Shop-Fabricated Aboveground Storage Tanks have been prepared as an industry service by the Petroleum Equipment Institute. The text represents the consensus views of the PEI Tank Closure Committee, comprised of the following members:

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1. INTRODUCTION

1.1 Origin. The Petroleum Equipment Institute (PEI) has produced this document as an industry service. It has been prepared in response to requests for a single authoritative source of information from underground storage tank (UST) and aboveground storage tank (AST) system owners/operators, tank and pump contractors, consultants, engineers, the safety industry, regulators and other individuals.

These recommended practices represent a synthesis of industry procedures relating to the closure of USTs and shop-fabricated ASTs. These practices are the consensus recommendations of the PEI Tank Closure Committee. The Committee is composed of representatives from equipment suppliers/manufacturers; tank contractor companies specializing in the design, installation and closure of tank systems; and environmental personnel from industries that operate storage tank systems. In addition, the Committee has had the benefit of comments submitted by parties interested in tank closure.

In instances when there were differences or omissions in material available from existing sources, the PEI Tank Closure Committee has included its own consensus recommendations based on the practical experience of Committee members. In some respects, these recommended practices may be more stringent than the requirements imposed by state and/or local regulations. However, these recommended practices do not attempt to cover all of the subjects addressed in the regulations for tank closure of USTs and shop-fabricated ASTs.

1.2 Background. The U.S. Environmental Protection Agency (EPA) issued its Technical Standards and Corrective Action Requirements for Owners and Operators of Underground Storage Tanks (UST). The standards appear in Part 280 of Volume 40 of the Code of Federal Regulations. Individual states may have more stringent requirements than outlined by the EPA. Therefore, the requirements of the authority having jurisdiction (AHJ) should be reviewed before commencing work. The AHJ is an organization, office or individual responsible for enforcing the requirements of a code or standard or for approving equipment, materials, an installation or a procedure.

The EPA has not drafted regulations for ASTs. However, AST management regulations have been developed at some state and local levels of government. Since the AHJ may have additional requirements, the appropriate government agencies should be consulted before taking any action suggested by these recommended practices.

The lack of uniform closure standards has resulted in diverse closure practices. Evolving factors, such as the emphasis on environmental protection, state and federal regulations, and safety considerations, also have necessitated that the closure of shop-fabricated ASTs and USTs be consistent and carefully planned.

1.3 Purpose. The purpose of this document is to provide consistent recommended practices for the safe closure of UST and shop-fabricated AST systems used to store petroleum products. It provides a summary of general guidelines for the decommissioning, removal, closure in place, storage, transportation and off-site disposal of USTs and shop-fabricated ASTs that have contained petroleum products.

The principal objectives of this recommended practice are to:

- promote consistent, safe universal closure practices;
- protect the environment;
- prevent future releases from UST and shop-fabricated AST systems no longer in service;
- identify and contain existing contamination discovered during closure.

1.4 Scope. These recommended practices apply to facilities that are equipped with regulated or non-regulated USTs and shop-fabricated ASTs, associated piping, diking and spill containment, and equipment intended to operate a system that contains petroleum products.

These recommended practices do not apply to:

- pressure vessels;
- field-erected tanks.

This document is not intended to endorse or recommend particular materials, equipment, suppliers or contractors.

The inclusion of procedures for the closure of USTs and shop-fabricated ASTs is not meant to imply that such procedures supersede any mandated regulatory requirements. This document also is not meant to provide interpretation of regulatory or legislative requirements related to closure of USTs and shop-fabricated ASTs.

1.5 Sources. The practices outlined in this document constitute a compilation of requirements and recommendations published by various organizations. References are listed in Appendix A.
1.6 Use of Other PEI Recommended Practices. Refer to the following PEI documents for additional recommended practices and procedures related to UST and AST systems:

- PEI/RP 100, Recommended Practices for Installation of Underground Liquid Storage Systems;
- PEI/RP 200, Recommended Practices for Installation of Aboveground Storage Systems for Motor Vehicle Fueling;

1.7 Regulations and Codes. USTs, shop-fabricated ASTs and the ancillary equipment discussed in these recommended practices may be regulated by AHJs, including federal, state, local, county, township and/or city authorities. While the general requirements of the regulations are similar, specific requirements may vary from jurisdiction to jurisdiction. The PEI Tank Closure Committee has not attempted to describe or interpret specific regulations in this document. Where there are differences between applicable regulations and the recommendations in the publication, the more stringent requirements should be followed.

UST owners and operators need to verify that the closure requirements meet all applicable regulatory requirements. Many jurisdictions require closure approvals and notifications to AHJs.

1.8 Importance of Competent Technicians. AHJs may require contractors to meet specific qualifications prior to the closure of tanks. In addition to what AHJs may require, the use of skilled, professional field contractors with experience in tank systems is an important factor to ensure that all regulatory, safety and technical requirements are met. The use of skilled contractors who have the experience and integrity to perform the job correctly provides the greatest assurance of being able to meet all safety, regulatory and technical requirements.

1.9 Training. Some states have certifications/licensing requirements for UST and AST closure contractors. Therefore, the use of a contractor licensed in those jurisdictions is required.

1.10 Notifications/Permits. Proper notifications, if required, must be made of intent to close a tank system. Obtain any required permits from or provide any notifications required to the appropriate AHJ.


2. SAFETY

2.1 General. Safety can add value to businesses, jobs and employees’ lives. Workplace injuries can be prevented by analyzing the workplace operations, establishing proper job procedures, and ensuring that all employees and contractors working at the jobsite are trained properly. Good safety practices can eliminate and/or prevent hazards in the workplace, provide safer and more effective work methods, reduce worker injuries and illnesses, avoid potential liability, reduce workers’ compensation costs and increase worker productivity. All personnel must demonstrate commitment to safety by following through to correct any unsafe conditions. This section is intended to identify specific hazards relating to the closure of tank systems.

NOTE: A competent authorized individual must be on-site at all times ensuring all safety conditions and requirements at the jobsite are met.

2.2 Safety and Health Program. A written safety and health program should be developed and implemented prior to tank closure activities. The program should be designed to identify, evaluate and control safety and health hazards, and provide for emergency response. The plan should be made available to all personnel who will be involved with tank closure activities. Reference OSHA Construction Standards and Regulations (29 CFR 1926) Subpart C for general safety requirements.

2.3 Safety Plan. A site-specific safety plan using a job hazard analysis (JHA) is required according to OSHA. The more thoroughly a job is planned, the more likely it will be completed successfully, on schedule, on budget, without incident and safely. Effective planning and communication is fundamental for contractors and employees to meet onsite contractual responsibilities. A JHA is a technique that concentrates on job tasks as a way to identify potential hazards before they occur. A JHA focuses on the relationship between the worker, task, tools and work environment. After the uncontrolled hazards are identified, steps can be taken to eliminate them and/or reduce them to an acceptable risk level.

A job safety plan (JSP) is another helpful tool to help organize, plan and communicate critical aspects associated with the work.

2.4 Lifting Equipment. Lifting equipment must be adequately sized to safely lift and load the tank being removed. The equipment should be operated by persons trained and experienced in the use of such equipment and in accordance with applicable OSHA standards.

2.5 Rigging. Those engaged in rigging activities must be adequately trained and experienced. Frequent and regular inspections should be performed on the rigging material and equipment by competent persons. Rigging that is identified as unsafe must not be used.

2.6 Fall Protection. Falls are among the most common causes of serious work-related injuries and deaths. Safety measures must be set up at the jobsite to prevent falling from overhead platforms, elevated work stations or into the excavation during removal of a tank. OSHA requires that fall protection be provided at elevations of 6 feet and higher in the construction industry. In addition, OSHA requires that fall protection be provided when working over dangerous equipment and machinery, regardless of the fall distance.

To prevent being injured from falls:

• Use fall protection such as safety harnesses, lanyards and lines, safety nets, stair railings and handrails, as required.
• Use proper barricades to guard every excavation into which someone can accidentally fall.

2.7 Electrical Hazards. Before any on-site work begins, ensure the workplace is safe by eliminating all electrical sources to the equipment being removed. Any electrical equipment used in tank system closures should be in accordance with NFPA-70, National Electrical Code. Before removing any electrical equipment, the contractor should verify the power is turned off and initiate lockout/tagout procedures.

NOTE: On-site personnel should be aware that electrical hazards can be underground and overhead.

2.8 Fire and Explosion Hazards. Most tank removals will involve flammable liquids and vapors from products stored in the tank and from accumulated residues left in the tank, even after it has been pumped dry. Be aware of the fire triangle: fuel, oxygen, ignition source. All three points of the triangle are necessary to support combustion and all are present during tank closure. Prevent all three from occurring simultaneously.

These three elements need to be recognized, evaluated and controlled to create a safe workplace and avoid a disaster. Safe tank removal requires continuous attention.
to these potential hazards to eliminate or reduce the risk of explosion.

The following items may be included on a pre-site inspection checklist to ensure there are no fire hazards.

- Ban smoking in the area.
- Shut down all open flame- and spark-producing equipment within the vapor hazard area. Site conditions may require a specific setback distance from the work area.
- Ensure that all electrical equipment is explosion-proof.
- Locate internal combustion equipment away from the area of vapor concentrations.
- Use only non-sparking tools to expose tank fittings and prepare for the vapor-freeing procedures.
- Control static electricity by either bonding or grounding equipment. Bonding is the process of electrically connecting two or more conductive objects so that they are brought to the same electrical potential, but not necessarily the same electrical potential as the earth. Grounding creates the presence of a bond between one or more electrically conductive objects and the earth, so that all objects are at zero (0) electrical potential.

**2.8.1 Static Electricity.** Static electricity is a common source of ignition and must be eliminated. Factors to consider regarding static electricity include the following.

- An atmosphere of low humidity is more prone to static electricity.
- Evaluate clothing, equipment and materials used on the jobsite to avoid static generation. Natural fiber clothing is less susceptible to static generation than synthetic fibers, such as nylon and polyester.
- Avoid using PVC suction tubes that do not incorporate an integrated grounding wire.
- Be aware that static electricity can occur when clothing comes into contact with tools or machinery.

**2.9 Testing for Flammable Vapors.** Continuous monitoring for the presence of flammable vapors is required for the safe removal of tanks and equipment that have contained combustible and flammable liquids. Flammable vapors are heavier than air and can accumulate in low points and confined areas, which could then present a fire and explosion hazard to people working in those areas. Low points can include pits, excavations, manholes, depressions, tank bottoms, sumps, utility vaults or any area that does not have proper ventilation.

**2.10 People Hazards/Public.** Precautions must be taken to keep workers and members of the public safe. Specific rules for the site may vary from one location to another. Some construction sites employ multiple contractors. Therefore, determine in advance who will be responsible for safeguards that protect the public, including the inspection and maintenance of those safeguards.

**2.11 Work Area Protection.** The best way to keep the public away from a construction site is to set up a perimeter using fences or barricades. Examples of barricades include caution tape, brightly colored plastic mesh and metal fencing. Post signs along the perimeter warning people not to enter the construction area. These measures can prevent pedestrians from inadvertently getting too close to work activities and also can deter curious onlookers who might otherwise attempt to enter the space.

In addition to the perimeter barricades, set fencing around any open, unattended excavation area at all times until the excavation is backfilled to its original ground surface level. Store equipment and materials inside the barricaded area to secure them after hours. If flammable liquids are stored on-site, ensure they are in appropriate containers.

**2.12 Vehicle Hazards.** Moving vehicles at the jobsite can pose a hazard. Workers should be aware of this danger. Include traffic control and barricades as part of the safety plan. Good design and planning in the pre-removal construction phase involving owners, operators, architects, designers, engineers and construction crews can significantly reduce the risk of vehicle accidents. Communication and cooperation with other contractors on-site will help ensure all workers are protected.

**2.13 Test Equipment.** Flammable or combustible vapors are likely to be present in the work area. The concentration of vapors in the tank, excavation or work area may reach the flammable or explosive range before venting is complete and a safe atmosphere is reached. Therefore, it is critical that the area being excavated is monitored for explosive levels of vapors.
When purging a tank, use a lower explosive level (LEL) meter. The mixture of vapor and oxygen could produce a fire or explosion in the presence of an ignition source. The LEL is based on the vapor concentration present. A reading from an LEL meter is the percentage of the LEL of the vapors present in an atmosphere. LEL is expressed as the percent of product vapor by volume in air. The meter reads from 0 percent to 100 percent of the LEL.

When inerting a tank, use an oxygen meter to test the atmosphere inside the tank. The goal when inerting a tank is to lower the oxygen level below 5 percent. This is below the level at which the atmosphere will not support combustion. The only way to verify that the oxygen level inside the tank is below 5 percent is through the use of a properly calibrated oxygen meter operated by a knowledgeable technician.

2.14 Confined Space Entry. Before any work commences at the worksite, each employer must identify all confined spaces in which one or more employees may work. Follow the confined space entry requirements noted in OSHA, Subpart AA, Section 1926, Con confined Spaces in Construction. Examples of confined spaces commonly found at tank removal sites include:

- interior of the tank;
- interior of tank sumps, dispenser sumps and transition sumps;
- interior of dikes and vaults.

Elements of each space should be considered and evaluated, including testing as necessary. Each employer must ensure that the identification of confined spaces is done by a competent person.

All efforts should be made to limit the amount of time that confined space entry activities occur during the tank removal process.

2.15 Spill Response. When engaging in tank closure activities, care should be taken to prevent spills. If a spill occurs, it should be contained and cleaned up immediately using suitable clean-up materials. Spills may need to be reported to the authority having jurisdiction (AHJ).

2.16 Excavation Safety. Many activities and measures must be considered when excavating.

(1) Before Excavation.

- Before you dig, call 811 or your local utility locator for utility identification and marking. Additional underground obstruction location services may need to be contacted.
- Set up necessary barricades, walkways, lighting and signs around the perimeter of the excavation.
- Have emergency equipment on-site, including at least two fire extinguishers with a minimum rating of 40-60 B:C dry chemical immediately accessible to the work area.

NOTE: Check the expiration date and inspection status on the fire extinguisher.

(2) During Excavation.

- Stay out of reach of the swing radius of the machine arm on any excavation equipment.
- Ensure personnel do not stand close to the edge of the excavation.

(3) During Removal.

- Only essential personnel should be in the tank removal area until the tank is out of the ground and stabilized.

2.17 Excavation Cave-Ins. Cave-ins are a primary excavation hazard and occur when the soil that forms the sides of the excavation cannot support the pressure put on it by equipment or gravity. Surge loads are created by placing an extra load on the soil surrounding the excavation. The additional weight or the presence of groundwater can lead to soil destabilization and side wall collapse. All excavated materials should be placed a minimum of 2 feet back from the excavation walls. Cave-in prevention methods can include sloping, benching or shoring the sides of the excavation. Reference OSHA standard 29 CFR 1926.652.

2.18 Additional Excavation Hazards. Many other hazards are associated with excavations:

- destabilizing adjacent structures leading to their collapse;
- encountering and damaging underground utilities (power, water, sewer, gas and telephone lines);
- traffic in close proximity to excavation activities;
- falling loads during the loading and unloading of earth, fill and other materials;
- entering and exiting excavations;
- heavier-than-air gasses, which may displace oxygen and cause an unseen hazard.

2.19 Climate/Weather. Prior to commencing any activities at a site, always consider the climate and
weather conditions from a construction planning and safety perspective.

2.20 Personal Protective Equipment (PPE). PPE includes all outer garments and accessories worn for the purpose of protecting the head, eyes, ears, torso, feet and respiratory system from health, safety and environmental hazards. The appropriate protection and clothing to wear varies depending on the predominant types of exposure. The level of protection assigned must match the possible hazard.

Final selection of PPE should be based on the full evaluation of the potential hazards expected during site operations. Therefore, a full evaluation of the hazards must be performed. As additional data becomes available or as site conditions or job functions change, it may be necessary to reevaluate and adjust the level of protection. The most important factor in selecting PPE is the nature of hazards that might be present at the jobsite.

2.21 Protective Equipment Types. PPE should be tailored to the specific jobsite. Some levels of PPE are regulated by OSHA. PPE commonly used at tank closure sites includes:

- head protection;
- hearing protection;
- eye and face protection;
- foot protection;
- hand protection;
- respiratory protection;
- protective clothing;
- high-visibility clothing.
### 3. VACUUM EQUIPMENT (TRUCKS AND SELF-CONTAINED VACUUM EQUIPMENT)

#### 3.1 General

Vacuum equipment is used for removal of liquids or residues. All appropriate grounding and bonding procedures should be followed.

The following procedures are recommended when employing vacuum equipment at the jobsite location:

- Direct any vacuum pump exhaust away from any possible ignition source.
- If a vacuum truck is used, it should be designed for the application and the operator should be qualified for the job.
- Vacuum equipment should be located as far as possible from the tank and flammable vapors, and outside of the probable path of vapor dispersion.
4. UNDERGROUND STORAGE TANKS

4.1 Closure Methods. This section outlines the proper procedures for underground storage tank (UST) system closure, including piping and/or ancillary equipment, hydrant systems and oil/water separators.

There are two types of UST closures.

4.1.1 Temporary Closure. Placing a UST system out of service for a limited period of time is considered temporary closure. The time frame for temporary closure is governed by the authority having jurisdiction (AHJ).

4.1.2 Permanent Closure: If the tank is regulated, permanent closure must be performed within the established regulatory time frame. Permanent closure can consist of either of the following.

- **Removal:** Permanently removing the UST system from the ground.
- **Closure in Place:** Placing the UST system permanently out of service by filling the tank with an inert, solid, non-shrinking material. Some local regulations and/or zoning ordinances may prohibit closure in place or the use of certain types of materials for closure in place.

4.2 Temporary Closure. A UST is considered temporarily out of service if it is idle but will be returned to service, or if it is awaiting determination for permanent closure.

4.2.1 Notification. When the decision has been made to place a tank in temporary closure, written regulatory notifications to the AHJ may be required. If working on airports or government properties, additional notifications may be required. In some instances, the county and/or city must be notified in addition to the other implementing agencies. Always check with AHJs prior to commencing temporary closure activities to identify any additional requirements.

4.2.2 Tasks. Tanks temporarily out of service must be properly safeguarded for the entire period of time they will be out of service. Tanks may be properly safeguarded by adhering to the following list of tasks.

1. Continue operation and maintenance of corrosion protection, including required periodic testing. For impressed current systems, all electrical connections must be maintained and the rectifier energized at all times. Rectifiers should be inspected every 60 days.

2. Continue required inspections of the tank.

3. Remove all stored product from the tank, lines and dispensing nozzle, or any other equipment containing product. A tank is considered empty if less than 2.5 centimeters (1 inch) of residue or less than 0.3 percent by weight of the total capacity of the UST system remains in the tank. If the tank does not meet this criterion, it is considered active even if the tank is not in use; all regulatory requirements still apply to the tank until such time that it meets the regulatory definition of empty.

4. Continued operation and maintenance of release detection is not required if the tank’s product volume is less than 2.5 centimeters (1 inch). Leak detection equipment should be properly decommissioned until the tank is either removed or brought back into service.

5. Cap, secure and lock all openings against tampering. Openings may include the fill pipe, gauge pipe, tank truck vapor recovery fitting and vapor return. Ensure water cannot enter the tank while it is in temporary closure.

6. Turn off power to all pumps, dispensers and submersible turbine pumps (STPs).

7. If no dispenser is present, cap and secure all product lines.

8. Leave all vent lines open.

4.3 Permanent Closure in Place. Permanent closure of a UST takes place through closure in place or removal from the ground in accordance with local regulations.

4.3.1 Notification. The proper written regulatory notifications to the responsible implementing agency must be made as required by the AHJ. If working on airport or government properties, additional notifications and/or approvals may be required from the governing agency where the site is located. In some instances, the county and/or city must be notified in addition to the other implementing agencies. Always check with the local jurisdiction in which the site is located prior to commencing any permanent closure activities.

4.3.2 Pre-Closure Evaluation. Prior to permanent closure of a UST, an evaluation of the site should be conducted.
(1) Ensure the persons supervising tank closure have the appropriate training, certifications, licenses and permits, as required by the AHJ.

(2) Identify the required equipment needed to complete the job task.

(3) Assess the potential for encountering contaminated backfill soil or water that may require special stockpiling and/or handling.

(4) Determine if dewatering of the excavation will be required.

(5) Identify an area for stockpiling excavated backfill and soils.

(6) Identify an area for temporary storage of the tank.

(7) Develop a plan for containing small spills when disconnecting the piping.

(8) Determine the method for purging or inerting the tank.

(9) Determine the method for cleaning the tank and disposing of the contents, including contaminated water used to rinse the tank.

(10) Develop a plan for transporting the tank.

(11) Determine if a site assessment will be required by the AHJ.

(12) Request as-built drawings, existing site drawings or photographs prior to commencing site activities.

4.4 Permanent Closure by Removal. The following tasks are recommended for closures involving removal of USTs.

(1) Notify the appropriate AHJ and underground utility organizations.

(2) Review and verify that the pre-closure checklist has been completed.

(3) Drain product piping into the tank and remove the product from the tank.

(4) Remove ancillary equipment.

(5) Respond to spills.

(6) Excavate to expose the top of the tank.

(7) Leave the tank in the excavation while cleaning and vapor-freeing unless doing so will create an unsafe condition.

(8) Clean the interior of the tank and remove residual liquids/sludge.

(9) Vapor-free the tank.

(10) Monitor the tank for explosive vapors or oxygen levels.

(11) Monitor the interstice where applicable.

(12) Access tank interior (optional).

(13) Remove the tank from the excavation.

(14) Remove the piping.

(15) Remove any water or sheen from the excavation if required by the AHJ and dispose of it properly.

(16) Backfill the excavation.

(17) Manage the removed tank by moving from the site, dismantling for disposal (if required) or destroying on-site.

NOTE: If the tank is equipped with Stage II vapor recovery, some AHJs may require proof and/or written notification of decommissioning before removal of a UST. Refer to PEI/RP 300, Recommended Practices for Installation and Testing of Vapor-Recovery Systems at Vehicle-Fueling Sites, for further decommissioning instructions.

4.4.1 Notifications. Call the AHJ and 811 for utility identification and marking before you dig. Additional underground obstruction location services may be required.

4.4.2 Pre-Closure Evaluation. Ensure steps outlined in Section 4.3.2 have been completed before commencing closure by removal.

4.4.3 Product Removal From Piping and Tank. The following precautions should be taken when removing product from the piping and tank.

4.4.3.1 Product Removal From Piping. Drain product piping into the tank, being careful to avoid any spillage into the excavation area. If necessary, an inert gas may be used to purge the piping.

4.4.3.2 Product Removal From Tank. Remove liquids and residues from the tank by using explosion-proof or air-driven pumps or vacuum equipment. Refer to Section 3 for proper vacuum procedures. A pressure washer using a surfactant may
be employed to rinse the tank and enhance removal of residues from the tank.

**WARNING:** Pump motors and suction hoses must be bonded to the tank or otherwise grounded to prevent electrostatic ignition hazards.

### 4.4.4 Ancillary Equipment Removal
Remove ancillary equipment, which may consist of:
- submerged turbine pumps;
- tank probes and sensors;
- fuel dispensers;
- fill caps and adaptors;
- overfill prevention equipment;
- tank-top sump equipment.

### 4.4.5 Spill Response
Be prepared to address any spills that may occur during tank removal. If required, report spills to the AHJ within the specified time frame.

### 4.4.6 Excavation to Tank Top
Remove overburden in the immediate tank excavation area and handle the stockpiled soil appropriately. While excavating, care should be taken not to damage or penetrate the tank top, piping, conduit or risers prior to their removal.

### 4.4.7 Leaving Tank in Excavation
Generally, the safest practice is to leave the tank in the excavation for access during cleaning, vapor-freeing and tank opening.

### 4.4.8 Cleaning Inside Tank
Product trapped in the sludge at the bottom of the tank, absorbed in the tank walls or trapped under the scale is a continuous source of flammable vapor regeneration. Cleaning the tank will decrease the amount of vapor regeneration.

The following methods can be used to clean the inside of the tank. Follow safety procedures:
- Enter the tank to manually clean.
- Pressure wash the tank with water and a surfactant.
- Use specialty cleaning agents.
- Use a vacuum truck.

Any sludge, residue or waste that is generated during tank cleaning must be disposed of properly.

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**FIGURE 4-1. Venturi Air Mover (Eductor)**
4.4.9 Vapor-Freeing Tank. All vapors should be vented from the tank at a minimum height of 12 feet above grade or 3 feet above any adjacent roof lines. There are two forms of vapor-freeing the tank: purging or inerting.

4.4.9.1 Purging. Purging is the removal of flammable vapors from a tank to deprive a potential fire of its source of fuel. Purging uses a flow of outside air to remove the fuel component from the fire triangle. The goal of purging a tank is to reduce flammable vapors in the tank to a safe level.

Purging is accomplished by using one of two types of equipment.

(1) A venturi air mover (eductor) creates a vacuum, draws the volatile vapors from the tank and introduces fresh air into the tank. It is important that the air is moved along the bottom of the tank. This can be accomplished by either using an existing drop tube or by attaching a suction tube to the venturi. The air movement equipment should be bonded or grounded to prevent generating and discharging static electricity. (See Figure 4-1.)

(2) A diffused air blower introduces fresh air into the tank at various levels through a diffuser pipe, and the vapors are forced out through the atmospheric vent on the tank. The diffuser pipe must be properly bonded or grounded to prevent static buildup. (See Figure 4-2.)

4.4.9.2 Inerting. Inerting is the displacement of oxygen from a tank to deprive a potential fire of its source of oxygen. Inerting is removing oxygen from the fire triangle.

Inerting a tank is accomplished by injecting an inert gas, such as nitrogen, or using dry ice to vaporize into carbon dioxide (CO$_2$) and remove oxygen from the tank.

A tank is properly inerted when the oxygen level reaches 5 percent or less of oxygen by volume in the tank’s atmosphere, as measured by an oxygen meter. As the inert gas accumulates in the tank, it displaces the oxygen, which then exits the tank through the vent. A vent is required to release the oxygen at least 12 feet above grade. The inert gas or dry ice is placed into the tank with all openings closed except for the vent.
4.4.9.2.1 Inerting with Nitrogen. Nitrogen gas is slowly introduced into the bottom of the tank from a hose connected to the nitrogen cylinder. Introducing nitrogen low in the tank is essential to effective inerting. Care must be taken in handling compressed nitrogen. Bonding or grounding the nozzle or hose to prevent static buildup is required. While inverting with nitrogen may be more expensive than using dry ice, introducing nitrogen achieves better dispersion of the inert gas within the tank.

4.4.9.2.2 Inerting with CO₂. CO₂ gas can be produced by distributing dry ice evenly over the greatest possible area in the bottom of the tank before the openings are plugged. The minimum amount of dry ice required varies (from 15 to 20 pounds per 1,000 gallons of tank capacity). The dry ice will release CO₂ gas as it changes from a solid to a gas. Regardless of the inerting method, an oxygen meter must be used to verify that the oxygen content is 5 percent oxygen by volume or less.

Inverting with compressed CO₂ gas is not recommended since doing so can be dangerous. Having the contents under pressure can build up static electricity during discharge of the gas. Also, the compressed CO₂ has a much larger temperature difference with the outside atmosphere than compressed nitrogen. The difference between compressed CO₂ and the atmosphere in the tank leads to condensation, which increases the generation of static electricity. CO₂ fire extinguishers should not be used for inverting flammable atmospheres.

WARNING: CO₂ fire extinguishers should not be used for inerting flammable atmospheres.

4.4.9.3 Encapsulation. Certain chemical agents will encapsulate hydrocarbon molecules and render flammable liquids and vapors nonflammable. Manufacturer instructions will determine the amount of product to be used and the method of application.

4.4.9.4 Vapor-Freeing Tank With Water. A tank can be made temporarily “safe” by filling the tank completely with water. This will displace flammable vapors and may remove some of the liquid gasoline left in the tank.

Fill the tank with water until the floating product, debris, sludge and residue reaches the tank opening, and properly dispose of the waste in accordance with AHJ requirements. Do not overfill the tank. Ensure no product or water is spilled into the excavation. While filling the tank with water, maintain a vent so the vapors will be discharged to a minimum of 12 feet above grade. The fill volume should not exceed the venting capacity. Observe all safety precautions. When the tank is free of vapor, pump out the water and dispose of it in accordance with all regulatory requirements.

Because the water must be pumped from the tank before the tank is removed from the ground, sludge and vapor regeneration still need to be addressed. If this method is used, caution must be taken. Once the water is removed and air is reintroduced into the tank, flammable vapors may regenerate over time. Therefore, testing must be conducted frequently with a combustible gas indicator (CGI).

4.4.9.5 Tank Monitoring. The success of the vapor-freeing methods noted above must be monitored with a vapor monitor capable of reading both oxygen and LEL. When performing a tank removal, it is critical that the atmosphere inside the tank,
in the excavation and in any other below-grade areas be monitored frequently.

4.4.9.6 Interstitial Monitoring. If the tank is double-walled, monitoring the interstitial space during removal may be difficult. Therefore, the interstitial monitoring cap must be removed, and the interstice visually inspected and checked with vapor monitoring equipment. If vapors are present, purging or inerting the interstitial space may be necessary.

The only way to determine if the atmosphere inside a tank is safe is to monitor it with an oxygen meter or with a CGI, which is also known as a lower explosive limit (LEL) meter. See Section 2.13. LEL meters measure the percentage of the LEL of the vapors in an atmosphere. The meter reads from 0 percent to 100 percent of the LEL. The mixture of vapor and oxygen could produce a fire or explosion in the presence of an ignition source. Meter readings should be taken at the bottom, middle and upper levels of the tank.

When inerting a tank to remove oxygen from the fire triangle, an oxygen meter—not an LEL meter—should be used. Most LEL meters use a catalytic sensor to measure the flammability of a substance. Catalytic sensors burn or oxidize the vapors within the sensor. The sensor needs sufficient oxygen to burn the vapors. Without a sufficient amount of oxygen, the sensor will not operate properly and may show a false LEL reading.

When purging a tank, LEL readings of 10 percent or less must be achieved and maintained until tank removal is complete. Ensure the probe is long enough to reach the bottom of the tank. The instrument should be cleared after each reading.

A properly calibrated LEL meter should be used to check for hazardous vapor concentrations in and around the work area. Calibrate LEL meters in accordance with manufacturer instructions.

The tank atmosphere and excavation area should be regularly monitored for flammable or combustible vapors until the tank is removed from the excavation and site. Personnel responsible for monitoring must be trained and be familiar with the use of the monitoring instrument.

4.4.10 Accessing Tank Interior. Methods of accessing the interior of the tank include the removal of an existing manway, cutting an opening in the tank or puncturing the tank with the excavator bucket. Reasons for accessing the interior of the tank could include:

- tank cleaning;
- removal of tank interior equipment;
- introduction of an inert fill material to close the tank in place;
- environmental investigations/sampling;
- scrap yard inspection;
- AHJ requirements.

4.4.11 Tank Removal From Excavation. Prior to removing the tank from the excavation, the tank should be cleaned and vapor-freed, as noted above, and ready to be safely removed.

The equipment used to remove the tank must have sufficient lifting capacity to safely remove the tank. Rigging equipment must be securely, properly and safely attached to the tank. One of the major dangers in tank removal is improper attachment of rigging equipment. Seriously deteriorated tanks may require alternative methods of removal from the excavation.

Follow all safety precautions during the tank removal activity. Stay out of reach of any excavation equipment swing arm by standing away from the excavation. Avoid entering the excavation if possible.

If contamination is discovered during excavation, notify the proper authorities and take steps to prevent further contamination.

After completing the excavation around the tank, sample and stockpile excavated backfill and soil in accordance with applicable regulations. Separate contaminated from non-contaminated soil on-site in the event the soil contains concentrations that are above the allowable concentrations under applicable regulations. Consult the AHJ concerning any
requirements for notification, site assessment or corrective actions.

Remove the tank from the excavation and place it on a level surface. Block the tank to prevent movement after removal and prior to loading onto a truck for transportation. Ensure all residues remaining in the tank are eliminated prior to tank removal to prevent potential contamination from leaching into the soil or subsurface. Use boiler plugs to seal any corrosion holes in the outer tank shell.

4.4.12 Piping Removal. Excavate around the piping to uncover and remove it from the excavation. As with the tank removal, adhere to local regulations including any requirements to remove all backfill material prior to conducting the tank closure report and taking soil samples. Ensure any residue in the piping is eliminated prior to piping removal so that it does not leach into the soil or subsurface. Any piping that cannot be removed or is abandoned in place should be drained, flushed, capped and secured.

4.4.13 Water Removal. Some excavations may contain water and require additional precautions during removal. A site survey/evaluation may be required to identify the subsurface conditions before commencing activity in the excavated area. The assessment will help provide advance notice of whether the excavated area contains water. During the assessment, depth-to-groundwater measurements will help determine what precautions need to be planned prior to excavation. If water is present in the tank excavation, additional activities may be required for removal, disposal and notifications to the AHJ.

Water in the excavation should be removed, as required, to permit the safe removal or disconnection of the tank anchoring.

4.4.14 Excavation Backfilling. The excavation should be backfilled with suitable fill material. When determining suitable fill, consideration should be given to future use of the area and proper compaction.

4.4.15 Removed Tank Management. After the tank is removed from the tank excavation, it may be removed from the site or dismantled on-site.

4.4.15.1 Tank Removal From the Site. Before the tank is removed from the site and if the tank has not been rendered unusable, plug or cap all accessible holes and ensure a 1/8-inch vent hole is present to prevent excessive differential pressure caused by temperature changes. Always position the tank with the vent plug on top of the tank during transportation and storage.

If tanks are not cut up or crushed on-site prior to removal from the site, they should be properly marked/identified with a warning. The label contents may include any of the following:

- **TANK's FORMER CONTENTS:** (Tank product);
- **NOT VAPOR FREE**;
- **NOT SUITABLE FOR STORAGE OF FOOD OR LIQUIDS**;
- **DATE OF REMOVAL: MONTH/DAY/YEAR**.

Tanks that have held leaded motor fuels (or whose service history is unknown) should be clearly labeled with the following information:

- **TANK HAS CONTAINED LEADED GASOLINE**;
- **LEAD VAPORS MAY BE RELEASED IF HEAT IS APPLIED TO TANK SHELL**.

4.4.15.2 Tank Destruction On-Site. The tank can be destroyed on-site prior to transportation if allowed by the AHJ. Destruction should be completed the day of the tank excavation, if possible. The tank should be scrapped and disposed of properly. Photographic documentation is recommended.

**WARNING:** No underground tanks may be used aboveground.

4.5 Permanent Closure In Place. Some states and jurisdictions will allow USTs to be closed in place. The AHJ must be notified and provide approval prior to any closure in place, usually 30 days in advance. Closure of the tank in place should be considered in the following
circumstances.

- The tank location, adjacent equipment or structures may be damaged or weakened if the tank were removed.
- Removal of the tank may be physically impossible.

Tanks that are to be closed in place have varying degrees of access. Tanks that have very limited access, such as when located under a building, pose site-specific issues that should be dealt with on a case-by-case basis. The following procedures are recommended, provided there is access to the tank.

(1) Remove any remaining product from the tank and piping.

(2) Clean the tank.

(3) Disconnect and remove the vent line, if accessible. If the vent line is not accessible, remove the portion above the surface and cap both ends.

(4) Before the tank has been filled, properly cap or plug any exposed piping or fittings.

(5) Remove any piping that can be removed. Piping that cannot be removed or is abandoned in place should be properly drained, capped and secured. If the piping can be removed, excavate around the piping to uncover and remove it from the excavation. As with the tank removal, adhere to local regulations including any requirements to remove all backfill material prior to conducting the tank closure report and taking soil samples. Ensure any residue in the piping is eliminated prior to removal of the piping so the residue does not leach into the soil or subsurface.

(6) Disconnect electrical power to the tank and equipment.

(7) Fill the tank with a solid inert material approved by the AHJ, such as cement slurry, clean sand, concrete, grout slurry, approved poly-foam materials or another similar substance. The suitable solid inert material should be introduced through openings in the top of the tank. It is important to completely fill the tank with a solid inert material.
5. ABOVEGROUND STORAGE TANKS

5.1 General. This section outlines closure of shop-fabricated aboveground storage tanks (ASTs). The tanks in this category have a capacity of less than 50,000 gallons. It is important to check state and local regulations for AST closure requirements.

5.2 Removal From Service. This method of preparing an AST for removal may be used when an AST system is being emptied but is intended to be returned to operational service, moved to another location or disposed of properly.

5.2.1 Tasks. The following tasks should be performed in preparation for the closure of the AST (temporary or permanent).

(1) Obtain permits and notify the appropriate AHJ, if necessary.

(2) Remove all power sources from the tank system.

(3) Remove all product from the tank and piping.

(4) Clean the tank.

(5) Vapor-free the tank.

(6) Cap, blind or remove all piping entering or exiting the tank, excluding vents, if applicable. (See section 4.4.12 for underground piping removal.)

(7) Cap and/or lock fill ports and label them as closed.

(8) If the AST has stairs, ensure they are blocked off or removed.

(9) Label the tank, as appropriate.

(10) Safeguard the physical security and integrity of the tank while it is out of service.

If the tank will be moved to another location, follow proper inspection procedures for reuse and transportation regulations.

Update the Spill Prevention, Control and Countermeasure (SPCC) plan accordingly with the change in tank status, if applicable.

5.2.2 Cleaning Inside Tank. Cleaning the tank is important because product trapped in the sludge at the bottom of the tank, absorbed in the tank walls or trapped under the scale is a continuous source of flammable vapor regeneration. Cleaning the tank will decrease the amount of vapor regeneration.

The methods shown here can be used to clean the inside of the tank.

- Enter the tank to manually clean.
- Pressure wash with water and a surfactant.
- Use specialty cleaning agents.
- Employ a vacuum truck.

Any waste that is generated during tank cleaning must be properly disposed.

5.2.3 Vapor-Freeing Tank. There are two forms of vapor-freeing the tank: purging or inerting. All vapors should be vented from the tank at a minimum height of 12 feet above grade or 3 feet above any adjacent rooflines.

5.2.3.1 Purging. Purging is the removal of flammable vapors from a tank to deprive a potential fire of its source of fuel. Purging uses a flow of outside air to remove the fuel component from the fire triangle. The goal of purging a tank is to reduce flammable vapors in the tank to a safe level. Purging is accomplished by using one of two types of equipment.

(1) A venturi air mover (eductor) creates a vacuum, draws the volatile vapors from the tank and induces fresh air into the tank. It is important that the air is moved along the bottom of the tank by either an existing drop tube or by providing a suction tube attached to the venturi (see Figure 5-1). The air movement equipment should be bonded or grounded to prevent the generation and discharge of static electricity.

(2) A diffused air blower introduces fresh air into the tank at various levels through a diffuser pipe and forces the vapors out through the atmospheric vent on the tank. The diffuser pipe must be properly bonded or grounded to prevent static buildup. (See Figure 6-2.)

5.2.3.2 Inerting. Inerting is the displacement of oxygen from a tank to
deprive a potential fire of a source of oxygen. Inerting uses an inert gas to remove oxygen from the fire triangle.

Inerting is accomplished by injecting an inert gas, such as nitrogen, or using dry ice that will vaporize into carbon dioxide (CO₂) to remove the oxygen from the tank. As the inert gas accumulates in the tank, it displaces the oxygen, which then exits the tank through the vent. A vent is required to release the vapors at least 12 feet above grade, which may be through the existing vent or a temporary vent. The inert gas or dry ice is placed into the tank with all openings closed except for the vent.

Nitrogen gas is slowly introduced into the tank from a hose that passes through a tank opening to the bottom of the tank. Introduce nitrogen low in the tank is essential to effective inerting. Care must be taken in handling compressed nitrogen. Bonding or grounding the nozzle or hose to prevent static buildup is required. While this alternative of inerting may be more expensive than using dry ice, better dispersion of the inert gas within the tank can be achieved.

CO₂ gas can be produced by distributing dry ice evenly over the greatest possible area in the bottom of the tank before the openings are plugged. Minimum amounts...
of dry ice vary from 15 to 20 pounds per 1,000 gallons of tank capacity. A tank is properly inerted when the oxygen level reaches 5 percent or less of oxygen by volume in the tank’s atmosphere, as measured by utilizing an oxygen meter. The dry ice will release CO$_2$ gas as it changes from a solid to a gas. Regardless of the inerting method, an oxygen meter must be used to verify the oxygen content.

Inerting with compressed CO$_2$ gas is not recommended. Having the contents under pressure can build up static electricity during discharge of the gas. Also, the compressed CO$_2$ has a much larger temperature difference with the outside atmosphere than compressed nitrogen. The difference between compressed CO$_2$ and the atmosphere in the tank leads to condensation, which increases the generation of static electricity. CO$_2$ fire extinguishers should not be used for inerting flammable atmospheres.

**WARNING:** CO$_2$ fire extinguishers should not be used for inerting flammable atmospheres.

5.2.4 Encapsulation. Certain chemical agents will encapsulate hydrocarbon molecules and render flammable liquids and vapors nonflammable. Manufacturer instructions will determine the amount of product to be used and the method of application.

5.2.5 Vapor-Freeing Tank With Water. A tank can be made temporarily safe by filling the tank completely with water. This will displace flammable vapors and may remove some of the liquid gasoline left in the tank.

Fill the tank with water until the floating product, debris, sludge and residue reaches the tank opening, and properly dispose of the waste in accordance with the requirements of the authority having jurisdiction (AHJ). Do not overfill the tank. Ensure no product or water is spilled. While filling the tank with water, maintain a vent so the vapors will be discharged to a minimum of 12 feet above grade. The fill volume should not exceed the venting capacity. Observe all safety precautions. When the tank is free of vapor, pump out the water and dispose of it in accordance with all regulatory requirements.

The water must be pumped from the tank. However, sludge and vapor regeneration still needs to be addressed. Once the water is removed and air reintroduced into the tank, flammable vapors may regenerate over time. Therefore, testing must be maintained frequently with a combustible gas indicator (CGI).

5.2.6 Tank Monitoring. The success of the vapor-freeing methods noted above must be checked with different types of monitoring equipment. When performing a tank removal, it is critical that the atmosphere in the tank be monitored frequently.

5.2.7 Interstitial Monitoring. With double-walled tanks, it may be difficult to monitor the interstitial space during removal. Therefore, the interstitial monitoring cap must be removed, and the interstice visually inspected and checked with vapor monitoring equipment. If vapors are present, it may be necessary to purge or inert the interstitial space.

The only way to determine if the atmosphere inside a tank is safe is to monitor it with either an oxygen meter or with a CGI, which is also known as an LEL meter. LEL meter readings express the percentage of the LEL of the vapors present in an atmosphere. The meter reads from 0 percent to 100 percent of the LEL. The lower explosive limit (LEL) is based on the vapor. The mixture of vapor and oxygen could produce a fire or explosion in the presence of an ignition source. LEL is expressed as the percent of product vapor by volume in air.

When inerting a tank to remove oxygen from the fire triangle, an oxygen meter, not an LEL meter, should be used. Most LEL meters use a catalytic sensor to measure the flammability of a substance. Catalytic sensors burn or oxidize the vapors within the sensor. The sensor needs sufficient oxygen to burn the vapors. Without a sufficient amount of oxygen, the sensor will not operate properly and may show a false LEL reading.

LEL readings of 10 percent or less must be achieved and maintained until tank removal is complete. Readings should be taken at the bottom, middle and upper levels of the tank. Ensure the probe length is long enough to reach the bottom of
the tank. Clean the instrument after each reading.

A properly calibrated LEL meter should be used to check for hazardous vapor concentrations in and around the work area. Calibrate LEL meters in accordance with manufacturer instructions.

5.2.8 Accessing Tank Interior (Optional). Methods of accessing the interior of the tank include the removal of an existing manway and cutting an opening in the tank. The reasons needed to access the interior of the tank could include the following:

- tank cleaning;
- removal of tank interior equipment;
- AHJ inspections;
- scrap yard inspection.

5.2.9 Transporting Tank. Before the tank is removed from the site, and if the tank has not been rendered unusable, plug or cap all accessible holes, and ensure a 1/8-inch vent hole exists to prevent the tank from excessive differential pressure caused by temperature changes. Always position the tank with the vent plug on top of the tank during transportation and storage.
6. DISPOSAL

6.1 Disposal Requirements. It is critical that the proper disposal methods are followed when disposing of an underground storage tank (UST) or an aboveground storage tank (AST). Prior to disposal of used tanks, check all regulatory requirements to determine if special procedures or preparations are required. There are three ways to dispose of a tank: recycling, or disposing at a landfill or scrapping.

6.2 Recycling Scrap Metal. Tank and piping that has been emptied, cleaned and recycled as scrap metal are specifically excluded from being considered a hazardous waste.

6.3 Landfill and Other Disposal Sites. Removed fiberglass tanks may be disposed of as construction debris at a permitted landfill. Fiberglass-clad tanks or wrapped steel tanks may have to be sent to a special facility that accepts that type of waste. Tanks that have been lined internally or coated externally with epoxy-based or similar materials may not be accepted by scrap facilities. Therefore, make prior inquiries and arrangements with the disposal facility regarding the requirements for accepting the tank.
7. DOCUMENTATION AND RECORDKEEPING

7.1 General. Maintain records demonstrating compliance with every portion of the closure requirements.

7.2 Tank Closure Report. Most states require that a tank closure report be completed for underground storage tanks. Some states require a closure report for certain aboveground storage tanks. Therefore, the owner should check with the authority having jurisdiction (AHJ) to determine if a tank closure report is required, including sampling requirements.

7.3 Record Retention. Retain records in accordance with the AHJ.
APPENDIX A
PUBLICATION REFERENCE

Many of the recommendations contained in this publication have been derived from the standards and recommended practices of other industry organizations. Listed below are the names, addresses, telephone numbers and websites of selected industry organizations, followed by the titles of their publications, which have some relation to this document.

■ AMERICAN PETROLEUM INSTITUTE

■ AMERICAN NATIONAL STANDARDS INSTITUTE
25 West 43rd Street, 4th Floor, New York, NY 10036. (212) 642-4900. www.webstore.ansi.org

■ INTERNATIONAL CODE COUNCIL
Publications, 4051 West Flossmoor Road, Country Club Hills, IL 60478-5795. (888) 422-7233. www.iccsafe.org

■ NATIONAL FIRE PROTECTION ASSOCIATION
1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02169-7471. (888) 344-3555. www.nfpa.org

■ NEW ENGLAND INTERSTATE WATER POLLUTION CONTROL COMMISSION (NEIWPCC)
85 Merrimac Street, Boston, MA 02114. (978) 323-7920. www.neiwpcc.org

■ PETROLEUM EQUIPMENT INSTITUTE
P.O. Box 2380, Tulsa, OK 74101-2380. (918) 494-9696. www.pei.org

■ U.S. DEPARTMENT OF LABOR, OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION
Occupational Safety and Health Administration, Title 29, Code of Federal Regulations (CFR), Part 1910, Occupational Safety and Health Standards.
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■ U.S. ENVIRONMENTAL PROTECTION AGENCY
Ariel Rios Building, 1200 Pennsylvania Avenue, NW, Washington, DC 20460. (202) 272-0167. www.epa.gov
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