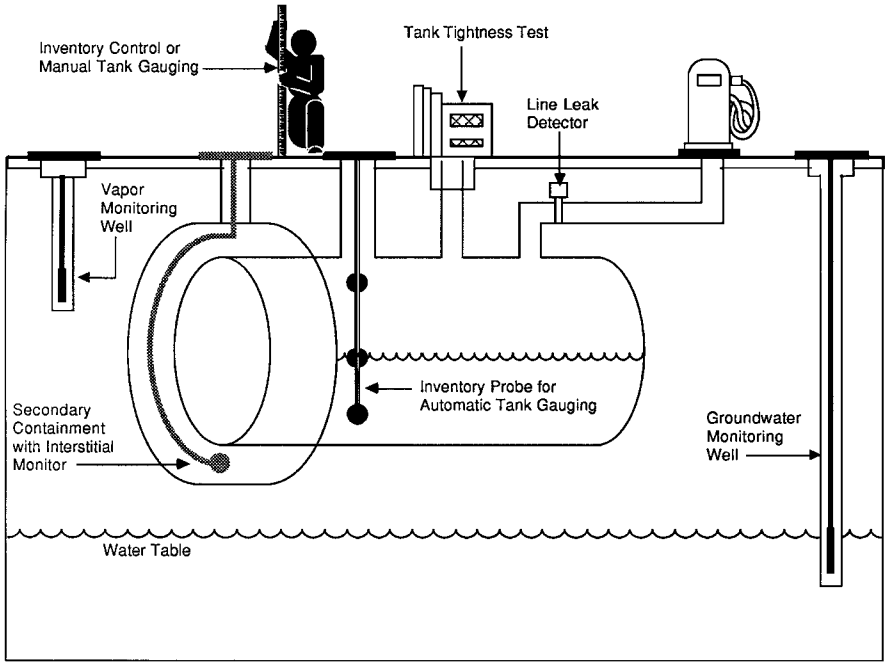
Straight Talk on Tanks

Leak Detection Methods For Petroleum Underground Storage Tanks And Piping



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Do You Have Questions About Leak Detection?

As an owner or operator of underground storage tanks (USTs) storing petroleum:

- Do you understand the basic leak detection requirements for USTs?
- Do you need help choosing the best leak detection method for your USTs?

These are important questions, because your UST and its underground piping must have leak detection in order to comply with federal law.

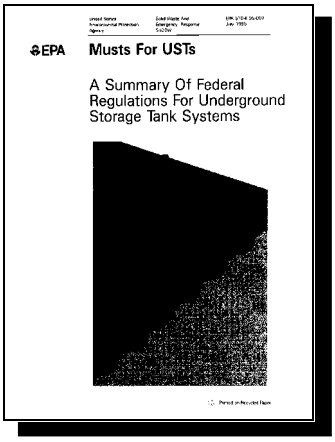
If your USTs do not meet the leak detection requirements described in this booklet, you can be cited for violations and fined.

This booklet begins with an overview of the federal regulatory requirements for leak detection. Each following section focuses on one leak detection method or the special requirements for piping.

You will find answers in this booklet to many basic questions about how leak detection methods work and which methods are best for your UST site.

Why is leak detection so important?

As of March 2005, almost 450,000 UST leaks had been confirmed. At sites without leak detection, leaks were discovered late, after contamination had spread, requiring difficult and costly cleanups.



By contrast, if you have effective leak detection, you can respond quickly to signs of leaks. You can minimize the extent of environmental damage and the threat to human health and safety. Early action on your part also protects you from the high costs that can result from cleaning up extensive leaks and responding to third-party liability claims.

If you need an overview of all the federal requirements for USTs, please refer to **Musts For USTs**, a booklet developed by the U.S. Environmental Protection Agency (EPA). You can order a free copy of this booklet by calling EPA's publication distributor at (800) 490-9198 (see inside the front cover for additional information) or downloading it from EPA's website at http://www.epa.gov/OUST/.

An Overview Of Leak Detection Requirements

All USTs installed after December 1988 must have leak detection when installed.

USTs installed before December 1988 had to meet leak detection compliance deadlines that were phased in over 5 years. **By December 1993, *all of these USTs* had to have leak detection.**

EPA has identified the following methods that owners and operators may use to meet the federal leak detection requirements:

- Secondary Containment With Interstitial Monitoring
- Automatic Tank Gauging Systems (including continuous ATG systems)
- Vapor Monitoring (including tracer compound analysis)
- Groundwater Monitoring
- Statistical Inventory Reconciliation
- Other Methods Meeting Performance Standards

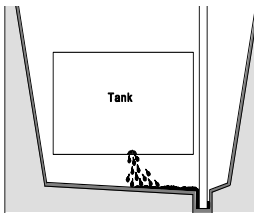
State or local regulations may differ from the federal requirements, so find out which requirements apply to your UST. See state UST contact information on page 28.

The leak detection methods noted above are all ***monthly monitoring methods*** and eventually everyone must use at least one of them. However, as a ***temporary*** method, you can combine tank tightness testing with inventory control (or with manual tank gauging if you have a small tank), as explained on page 4.

Underground piping connected to your USTs must also have leak detection. See pages 22-25 for descriptions of the requirements for piping.

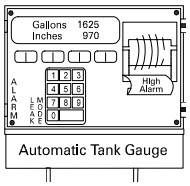
Brief descriptions of leak detection methods appear on the next two pages. More complete descriptions appear in the following sections.

- **Secondary Containment With Interstitial Monitoring** (see pages 6-7)



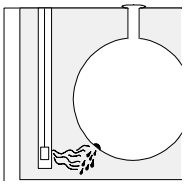
  Secondary containment often uses a barrier, an outer wall, a vault, or a liner around the UST or piping. Tanks can be equipped with inner bladders that provide secondary containment. Leaked product from the inner tank or piping is directed towards an interstitial monitor located between the inner tank or piping and the outer barrier.

  There are a number of interstitial monitoring methods. These methods include the use of a simple dipstick or a continuous, automated vapor or liquid sensor permanently installed in the system to monitor interstitial spaces. Interstitial spaces can also be filled with brine or glycol solutions and their levels monitored. Also, sophisticated pressure/vacuum monitoring systems may be used to indicate pressure changes within these spaces.



- **Automatic Tank Gauging Systems (including continuous ATG systems)** (see pages 8-9)

  A probe permanently installed in the tank is wired to a monitor to provide information on product level and temperature. These systems automatically calculate the changes in product volume that can indicate a leaking tank.

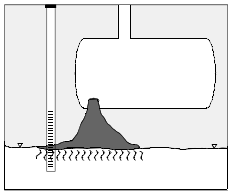


- **Vapor Monitoring (including tracer compound analysis)** (see pages 10-11)

  Vapor monitoring measures either product fumes in the soil around the UST or special tracer chemicals added to the UST which escape in order to check for a leak. This method requires installation of carefully placed monitoring wells. Vapor monitoring can be performed manually on a periodic basis or continuously using permanently installed equipment.

- **Groundwater Monitoring** (see pages 12-13)

  Groundwater monitoring senses the presence of liquid product floating on the groundwater. This method requires installation of monitoring wells at strategic locations in the ground near the tank and along the piping runs. To discover if leaked product has reached groundwater, these wells can be checked periodically by hand or continuously with permanently installed equipment. This method cannot be used at sites where groundwater is more than 20 feet below the surface.



- **Statistical Inventory Reconciliation** (see pages 14-15)

  In this method, a trained professional uses sophisticated computer software to conduct a statistical analysis of inventory, delivery, and dispensing data, which you must supply regularly. Also, the owner can purchase software and enter data into his own computer, which statistically analyzes the data.

- **Other Methods Meeting Performance Standards**

  Any technology can be used if it meets a performance standard of detecting a leak of 0.2 gallons per hour with a probability of detection of at least 95 percent and a probability of false alarm of no more than 5 percent. Regulatory authorities can approve another method if you demonstrate that it works as well as one of the methods above and you comply with any condition the authority imposes.

- **Tank Tightness Testing With Inventory Control** (see pages 16-19)

  This method **combines** periodic tank tightness testing with monthly inventory control. Inventory control involves taking measurements of tank contents and recording amount pumped each operating day, as well as reconciling all this data at least once a month. This combined method must also include tightness tests, which are sophisticated tests performed by trained professionals. ***This combined method can be used only temporarily*** (usually for 10 years or less)—see page 19 for time restrictions.

- **Manual Tank Gauging** (see pages 20-21)

  Manual tank gauging can be used only for tanks of 2,000 gallons or less capacity. This method requires keeping the tank undisturbed for at least 36 hours each week, during which the contents of the tank are measured twice at the beginning and twice at the end of the test period. At the end of each week you compare the results to the standards shown on page 21 to see if your tank may be leaking. This method can be used by itself only for tanks up to 1,000 gallons. Tanks between 1,001 and 2,000 gallons can use this method only in combination with periodic tank tightness testing. ***This combined method can be used only temporarily*** (usually for 10 years or less)—see page 21 for time restrictions.

Make sure the vendor of the leak detection method you use has provided you with evidence that your leak detection meets regulatory requirements for performance.

Look For The Proof Of A Third-Party Evaluation

An evaluation performed by a third party (someone who is independent of the manufacturer or vendor of the leak detection system) shows that a leak detection system can work as designed. The evaluation follows required evaluation procedures and often takes place in a laboratory. EPA and third parties have developed evaluation procedures for all leak detection systems.

Although an evaluation and its resulting documentation are technical, you should be familiar with the evaluation's report and its results form. You should obtain this documentation from the leak detection vendor and keep it on file. The report also contains a signed certification that the system performed as described, as well as documenting any limitations of the system. This information is important to your compliance with the UST requirements. For example, if a tank tightness test was evaluated and certified only for tests taking 2 hours or more, then your UST must be tested for at least 2 hours or it would fail to meet the leak detection requirements.

Required Probabilities For Some Leak Detection

The regulations require not only that leak detection methods be able to detect certain leak rates, but that they also give the correct answer consistently. In general, methods must detect the specified leak rate with a probability of detection of at least 95 percent and a probability of false alarm of no more than 5 percent. Simply stated, this means that, of 100 tests of USTs leaking at the specified rate, at least 95 of them must be correctly detected. It also means that, of 100 tests of non-leaking USTs, no more than 5 can be incorrectly called leaking. This is what is meant by the probabilities noted in this booklet.

Which leak detection method is best for you?

There is no one leak detection system that is best for all sites, nor is there a particular type of leak detection that is consistently the least expensive. Each leak detection method has unique characteristics. For example, vapor detection devices work rapidly and most effectively in porous soils, while liquid detectors are only appropriate for areas with a high water table.

Some states maintain lists of those leak detection systems that have been evaluated by third parties. Check with your state to see which systems are allowed in your state. See state UST contact information on page 28.

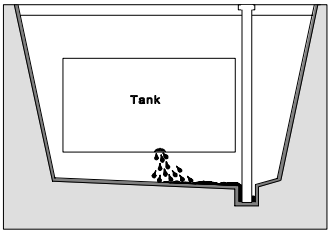
Identifying the best leak detection choice for your UST depends on a number of factors including cost (both initial installation cost and long-term operation and maintenance cost), facility configuration (such as complexity of piping runs and manifolded tanks), groundwater depth, soil type, seasonal rainfall and temperature ranges, availability of experienced installers, and other variables.

You should look around extensively for experienced, professional vendors and installers of leak detection. Ask questions that help you find the most reliable, cost-effective leak detection for your type of facility. Some possible information sources are: references from fellow UST owners, oil marketers, equipment suppliers, trade journals, trade associations, state and local trade associations (especially those for petroleum marketers and UST owners), and state and local regulatory authorities. (See state UST contact information on page 28.) Your state may also have an assistance fund that may be able to help you pay for your UST's leak detection.

The National Work Group on Leak Detection Evaluations (NWGLDE) – an independent group – also maintains a list of leak detection equipment whose third-party conducted documentation has been reviewed by the group. The list contains a detailed summary of specifications for over 325 leak detection systems. Although the list can be used to help select systems and determine their compliance or acceptability, the publication is not a list of approved leak detection systems. Approval or acceptance of leak detection systems rests with the implementing agency, in most cases the state environmental agency. The list can be accessed via the Internet at www.nwglde.org.

For additional information about federal UST requirements, visit EPA's website at www.epa.gov/OUST/.

Secondary Containment With Interstitial Monitoring



Will you be in compliance?

When installed and operated according to the manufacturer's specifications, secondary containment with interstitial monitoring meets the federal leak detection requirements for USTs. Operation of the monitoring device at least once each month fulfills the requirements for the life of the tank. Secondary containment with interstitial monitoring can also be used to detect leaks from piping (see the section on leak detection for piping starting on page 22).

How does the leak detection method work?

Secondary containment

- Secondary containment provides a barrier between the tank and the environment. The barrier holds the leak between the tank and the barrier so that the leak is detected. The barrier is shaped so that a leak will be directed towards the interstitial monitor.
- Barriers include:
  - Double-walled or jacketed tanks, in which an outer wall partially or completely surrounds the primary tank;
  - Internally fitted liners (i.e., bladders); and
  - Leakproof excavation liners that partially or completely surround the tank.
- Clay and other earthen materials cannot be used as barriers.

Interstitial monitors

- Monitors are used to check the area between the tank and the barrier for leaks and alert the operator if a leak is suspected.
- Some monitors indicate the physical presence of the leaked product, either liquid or gaseous. Other monitors check for a change in condition that indicates a hole in the tank (such as a loss of vacuum or pressure) or a change in the level of a monitoring liquid (such as a brine or glycol solution) between the walls of a double-walled tank.
- Monitors can be as simple as a dipstick used at the lowest point of the containment to see if liquid product has leaked and pooled there. Monitors can also be sophisticated automated systems that continuously check for leaks.

What are the regulatory requirements?

- The barrier must be immediately around or beneath the tank.
- The interstitial monitor must be checked at least once every 30 days.
- A double-walled system must be able to detect a release through the inner wall.
- An excavation liner must:
  - Direct a leak towards the monitor;
  - Not allow the specific product being stored to pass through it any faster than 10^{-6} cm/sec;
  - Be compatible with the product stored in the tank;
  - Not interfere with the UST's cathodic protection;
  - Not be disabled by moisture;
  - Always be above the groundwater and the 25-year flood plain; and
  - Have clearly marked and secured monitoring wells, if they are used.
- A bladder must be compatible with the product stored and must be equipped with an automatic monitoring device.

Find out if there are state or local requirements on the use of secondary containment that differ from those described here.

Will it work at your site?

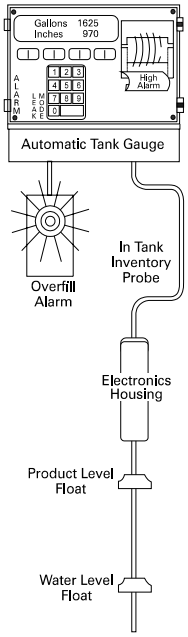
- In areas with high groundwater or a lot of rainfall, it may be necessary to select a secondary containment system that completely surrounds the tank to prevent moisture from interfering with the monitor.

Anything else you should consider?

- This method works effectively only if the barrier and the interstitial monitor are installed correctly. Therefore, trained and experienced installers are necessary.

Automatic Tank Gauging Systems

Will you be in compliance?



When installed and operated according to the manufacturer's specifications, automatic tank gauging systems (ATGS) meet the federal leak detection requirements for ***tanks*** (this method does not detect piping leaks). A test performed each month fulfills the requirements for the life of the tank. (For additional requirements for piping, see the section on leak detection for piping starting on page 22.)

How does the leak detection method work?

- The product level and temperature in a tank are measured continuously and automatically analyzed and recorded by a computer.
- In the inventory mode, the ATGS replaces the use of the gauge stick to measure product level and perform inventory control. This mode records the activities of an in-service tank, including deliveries.
- In the test mode, the tank is taken out of service and the product level and temperature are measured for at least one hour. Some systems, known as continuous ATGS, do not require the tank to be taken out of service to perform a test. This is because these systems can gather and analyze data during many short periods when no product is being added to or taken from the tank.
- Some methods combine aspects of automatic tank gauges with statistical inventory reconciliation. See pages 14-15 for more information about these methods

What are the regulatory requirements?

- The ATGS must be able to detect a leak of 0.2 gallons per hour with certain probabilities of detection and of false alarm. Some ATGS can also detect a leak of 0.1 gallons per hour with the required probabilities.

Will it work at your site?

- ATGS have been used primarily on tanks containing gasoline or diesel. Some systems have been evaluated for use on tank capacities of up to 75,000 gallons. If considering using an ATGS for products other than gasoline or diesel, discuss its applicability with the manufacturer's representative. Check the method's evaluation to confirm that it will meet regulatory requirements and your needs.
- Water around a tank may hide a leak by temporarily preventing the product from leaving the tank. To detect a leak in this situation, the ATGS should be capable of detecting water in the bottom of a tank.

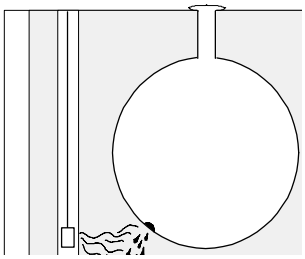
Anything else you should consider?

- The ATGS probe is permanently installed through an opening (not the fill pipe) on the top of the tank.
- With the exception of some continuous ATGS evaluated to perform on manifolded tanks, each tank at a site must be equipped with a separate probe. Check the method's evaluation to determine if the ATGS can be used with manifolded tanks.
- The ATGS probe is connected to a console that displays ongoing product level information and the results of the monthly test. Printers can be connected to the console to record this information.
- ATGS are often equipped with alarms for high and low product level, high water level, and theft.
- ATGS can be linked with computers at other locations, from which the system can be programmed or read.
- For ATGS that are not of the continuous type, no product should be delivered to the tank or withdrawn from it for at least 6 hours before the monthly test or during the test (which generally takes 1 to 6 hours).
- An ATGS can be programmed to perform a test more often than once per month (a recommended practice).
- Some ATGS may be evaluated to test at relatively low capacities (e.g., 25% or 30%). Although the product level at such capacities may be valid for the test equipment, it may not appropriately test all portions of the tank that routinely contain product. The ATGS test needs to be run to test the tank at the capacity to which it is routinely filled.

Find out if there are state or local requirements on the use of ATGS that differ from those described here.

Vapor Monitoring (Including Tracer Compound Analysis)

Will you be in compliance?



When installed and operated according to the manufacturer's instructions, vapor monitoring meets the federal leak detection requirements for USTs. Vapor monitoring denotes sampling for petroleum hydrocarbons (e.g., gasoline) that are sufficiently volatile to be picked up in the monitoring well/sampling point. However, the federal regulations also recognize sampling for tracer compounds introduced in the UST system. Operation of a vapor monitoring system at least once each month fulfills the requirements for the life of the tank. Vapor monitoring can also be installed to detect leaks from piping (see the section on leak detection for piping starting on page 22).

How does the leak detection method work?

- Vapor monitoring senses or measures fumes from leaked product in the soil around the tank to determine if the tank is leaking.
- Tracer compound analysis samples for the presence of a tracer compound outside the UST system that was introduced in the tank or underground piping.
- Fully automated vapor monitoring systems have permanently installed equipment to continuously or periodically gather and analyze vapor samples and respond to a release with a visual or audible alarm.
- Tracer compound analysis requires the installation of monitoring wells/sampling points strategically placed in the tank backfill or along pipe runs to intercept special chemicals that, in the event of a leak, are picked up in the sampling points.
- Manually operated vapor monitoring systems range from equipment that immediately analyzes a gathered vapor sample to devices that gather a sample that must be sent to a laboratory for analysis. Manual systems must be used at least once a month to monitor a site. Tracer compound analysis may be performed on a monthly or less frequent basis by qualified technicians.
- All vapor monitoring devices should be periodically calibrated according to the manufacturer's instructions to ensure that they are properly responding.
- Before installation of a vapor monitoring system for release detection, a site assessment is necessary to determine the soil type, groundwater depth and flow direction, and the general geology of the site. This can only be done by a trained professional.
- The number of wells and their placement is very important. Only an experienced contractor can properly design and construct an effective monitoring well system. Vapor monitoring requires the installation of monitoring wells within the tank backfill. A minimum of two wells is recommended for a single tank excavation. Three or more wells are recommended for an excavation with two or more tanks. Some state and local agencies have developed regulations for monitoring well placement.

What are the regulatory requirements?

- The UST backfill must be sand, gravel or another material that will allow the petroleum vapors or tracer compound to easily move to the monitor.
- The backfill should be clean enough that previous contamination does not interfere with the detection of a current leak.
- The substance stored in the UST must vaporize easily so that the vapor monitor can detect a release. Some vapor monitoring systems do not work well with diesel fuel.
- High groundwater, excessive rain, or other sources of moisture must not interfere with the operation of vapor monitoring for more than 30 consecutive days.
- Monitoring wells must be secured and clearly marked.

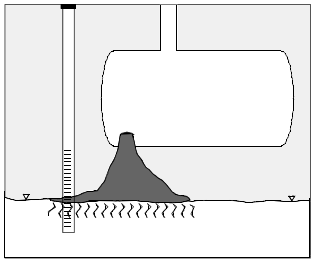
Find out if there are state or local requirements on the use of vapor monitoring that differ from those described here.

Will it work at your site?

- Before installing a vapor monitoring system, a site assessment must be done to determine whether vapor monitoring is appropriate at the site. A site assessment usually includes at least a determination of the groundwater level, background contamination, stored product type, and soil type. This assessment can only be done by a trained professional.

Groundwater Monitoring

Will you be in compliance?



When installed and operated according to the manufacturer's instructions, a groundwater monitoring system meets the federal leak detection requirements for USTs. Operation of a groundwater monitoring system at least once each month fulfills the requirements for the life of a tank. Groundwater monitoring can also be used to detect leaks in piping (see the section on leak detection for piping starting on page 22).

How does the leak detection method work?

- Groundwater monitoring involves the use of permanent monitoring wells placed close to the UST. The wells are checked at least monthly for the presence of product that has leaked from the UST and is floating on the groundwater surface.
- The two main components of a groundwater monitoring system are the monitoring well (typically a well of 2-4 inches in diameter) and the monitoring device.
- Detection devices may be permanently installed in the well for automatic, continuous measurements for leaked product.

NOTE: Groundwater monitoring cannot be used at sites where groundwater is more than 20 feet below the

- Detection devices are also available in manual form. Manual devices range from a bailer (used to collect a liquid sample for visual inspection) to a device that can be inserted into the well to electronically indicate the presence of leaked product. Manual devices must be used at least once a month.
- Before installation, a site assessment is necessary to determine the soil type, groundwater depth and flow direction, and the general geology of the site. This assessment can only be done by a trained professional.
- The number of wells and their placement is very important. Only an experienced contractor can properly design and construct an effective monitoring well system. A minimum of two wells is recommended for a single tank excavation. Three or more wells are recommended for an excavation with two or more tanks. Some state and local agencies have developed regulations for monitoring well placement.

What are the regulatory requirements?

- Groundwater monitoring can only be used if the stored substance does not easily mix with water and floats on top of water.
- If groundwater monitoring is to be the sole method of leak detection, the groundwater must not be more than 20 feet below the surface, and the soil between the well and the UST must be sand, gravel or other coarse materials.
- Product detection devices must be able to detect one-eighth inch or less of leaked product on top of the groundwater.
- Monitoring wells must be properly designed and sealed to keep then from becoming contaminated from outside sources. The wells must also be clearly marked and secured.
- Wells should be placed in the UST backfill so that they can detect a leak as quickly as possible.

Find out if there are state or local requirements on the use of groundwater monitoring that differ from those described here.

Will it work at your site?

- In general, groundwater monitoring works best at UST sites where:
  - Monitoring wells are installed in the tank backfill; and
  - There are no previous releases of product that would falsely indicate a current release.
- A professionally conducted site assessment is critical for determining these site-specific conditions.

Statistical Inventory Reconciliation

Will you be in compliance?

Statistical inventory reconciliation (SIR), when performed according to the vendor's specifications, meets federal leak detection requirements for USTs as follows. SIR with a 0.2 gallon per hour leak detection capability meets the federal requirements for monthly monitoring for the life of the tank and piping. SIR with a 0.1 gallon per hour leak detection capability meets the federal requirements as an equivalent to tank tightness testing. SIR can, if it has the capability of detecting even smaller leaks, meet the federal requirements for line tightness testing as well. (For additional requirements for piping, see the section on leak detection for piping starting on page 22.)

How does the leak detection method work?

- SIR analyzes inventory, delivery, and dispensing data collected over a period of time to determine whether or not a tank system is leaking.
- Each operating day, the product level is measured using a gauge stick or other tank level monitor. You also keep complete records of all withdrawals from the UST and all deliveries to the UST. After data have been collected for the period of time required by the SIR vendor, you provide the data to the SIR vendor.
- The SIR vendor uses sophisticated computer software to conduct a statistical analysis of the data to determine whether or not your UST system may be leaking. The SIR vendor provides you with a test report of the analysis. Also, you can purchase SIR software which performs this same analysis and provides a test report from your own computer.
- Some methods combine aspects of automatic tank gauges with statistical inventory reconciliation. In these methods, sometimes called hybrid methods, a gauge provides liquid level and temperature data to a computer running SIR software, which performs the analysis to detect leaks.

You can order a free booklet,* Introduction To Statistical Reconciliation, *that describes the use of this method. See inside the front cover for ordering information.

What are the regulatory requirements?

- To be allowable as monthly monitoring, a SIR method must be able to detect a leak at least as small as 0.2 gallons per hour and meet the federal regulatory requirements regarding probabilities of detection and of false alarm. Data must be submitted at least monthly.
- To be allowable as an equivalent to tank tightness testing, a SIR method must be able to detect a leak at least as small 0.1 gallons per hour and meet the federal regulatory requirements regarding probabilities of detection and of false alarm.

- The individual SIR method must have been evaluated with a test procedure to certify that it can detect leaks at the required level and with the appropriate probabilities of detection and of false alarm.

- The method's evaluation must reflect the way the method is used in the field. If a SIR method is not performed by the SIR vendor, then the method's evaluation must be done without the involvement of the SIR vendor. Examples of this situation are SIR methods licensed to owners and hybrid ATGS/SIR methods.

- If the test report is not conclusive, you must take the steps necessary to find out conclusively whether your tank is leaking. Because SIR requires multiple days of data, you will probably have to use another method.

- You must keep on file both the test reports and the documentation that the SIR method used is certified as valid for your UST system.

Will it work at your site?

- Some SIR methods have been evaluated for use on tanks up to 60,000 gallons in capacity. If you are considering using a SIR method, check the method's evaluation to confirm that it will meet regulatory requirements and your specific UST system needs.

- A SIR method's ability to detect leaks declines as throughput increases. If you are considering using a SIR method for high throughput UST systems, check the method's evaluation to confirm that it will meet regulatory requirements and your needs.

- Water around a tank may hide a hole in the tank or distort the data to be analyzed by temporarily preventing a leak. To detect a leak in this situation, you should check for water at least once a month.

Find out if there are state or local requirements on the use of statistical inventory reconciliation that differ from those

Anything else you should consider?

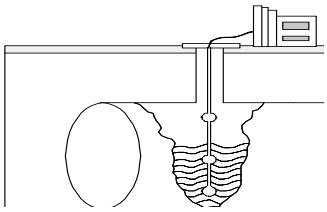
- Data, including product level measurements, dispensing data, and delivery data, should all be carefully collected according to the SIR vendor's specifications. Poor data collection produces inconclusive results and noncompliance.

- The SIR vendor will generally provide forms for recording data, a calibrated chart converting liquid level to volume, and detailed instructions on conducting measurements.

- SIR should not be confused with other release detection methods that also rely on periodic reconciliation of inventory, withdrawal, and delivery data. Unlike manual tank gauging or inventory control, SIR uses a sophisticated statistical analysis of data to detect releases.

Tank Tightness Testing With Inventory Control

Will you be in compliance?



When performed according to the manufacturer's specifications, periodic tank tightness testing combined with monthly inventory control can ***temporarily*** meet the federal leak detection requirements for ***tanks*** (this method does not detect piping leaks). See page 19 for time restrictions.

These two leak detection methods must be used together because neither method alone meets the federal requirements for leak detection for tanks. Tightness testing is also an option for underground piping, as described in the section on leak detection for piping starting on page 22.

Because they must be used together, both tank tightness testing and inventory control are discussed in this section. Tank tightness testing is discussed first, followed by inventory control.

Tank Tightness Testing

How does the leak detection method work?

Tightness tests include a wide variety of methods. These methods can be divided into two categories: volumetric and nonvolumetric. Tightness test methods are also referred to as precision tank tests.

- Volumetric test methods generally involve measuring very precisely (in milliliters or thousandths of an inch) the change in product level in a tank over time. Additional characteristics of this category of tank tightness testing include:
  - Changes in product temperature also must be measured very precisely (thousandths of a degree) at the same time as level measurements, because temperature changes cause volume changes that interfere with finding a leak.
  - The product in the tank is required to be at a certain level before testing. This often requires adding product from another tank on-site or purchasing additional product.
  - A net decrease in product volume (subtracting out volume changes caused by temperature) over the time of the test indicates a leak.
  - A few of these methods measure properties of product that are independent of temperature, such as mass and so do not need to measure product temperature.
- Nonvolumetric methods use acoustics or vacuum or pressure decay to determine the presence of a hole in the tank.
  - Various nonvolumetric methods are used to test either the wetted portion of the tank (that part containing product) or the ullage (unfilled portion of the tank that does not contain product) of the UST.
  - Nonvolumetric testing involving acoustics interprets an ultrasonic signal.
  - Tracer chemicals can also be circulated through the UST system and tested in strategically placed sampling ports.

- For both volumetric and nonvolumetric (except tracer compounds) test methods, the following generally apply:
  - The testing equipment is temporarily installed in the tank, usually through the fill pipe.
  - The tank must be taken out of service for the test.
  - Some tightness test methods require all of the measurements and calculations be made by hand by the tester. Other tightness test methods are highly automated. After the tester sets up the equipment, a computer controls the measurements and analysis.

Find out if there are state or local requirements on the use of these methods that differ from those described here.

- Some automatic tank gauging systems are capable of meeting the regulatory requirements for tank tightness testing and may be considered an equivalent method. Check with your implementing agency.

What are the regulatory requirements?

- The tightness test method must be able to detect a leak at least as small as 0.1 gallon per hour with certain probabilities of detection and of false alarm. To meet leak detection requirements, tank tightness testing must be combined with either inventory control or manual tank gauging, as described on pages 18 and 20.

- UST systems must have the combined method using tank tightness testing every 5 years for no more than10 years following corrosion protection, spill, and overfill upgrade of tanks (no later than December 1998) or installation of new tanks. For some USTs which had corrosion protection before the entire UST system met upgrade standards, the combined method using tank tightness testing every 5 years may be valid for less than 10 years.

- Ten years after upgrade or installation of a new UST system, you must have a monitoring method that can be performed at least once per month. See the other sections of this booklet for allowable monthly monitoring options.

Anything else you should consider?

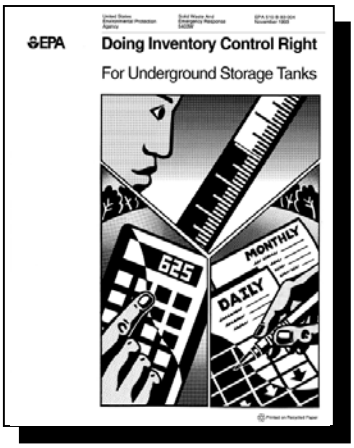
- For most methods, the test is performed by a testing company. You just observe the test.

- Depending on the method, tank tightness testing can be used on tanks of varying capacity containing gasoline and diesel. Many test methods have limitations on the capacity of the tank or the amount of ullage (unwetted portion of the tank not filled with product) that should not be exceeded. Methods that use tracer chemical analysis do not have limitations on tank capacity. If you are considering using tightness testing for products other than gasoline or diesel, discuss the method's applicability with the manufacturer's representative. Check the method’s evaluation to confirm that it will meet regulatory requirements and your specific UST system needs.

- Manifolded tanks generally should be disconnected and tested separately.

- Procedure and personnel, not equipment, are usually the most important factors in a successful tightness test. Therefore, well-trained and experienced testers are very important. Some states and local authorities have tester certification programs.

Inventory Control



How does the leak detection method work?

Inventory control requires frequent measurements of tank contents and math calculations that let you compare your stick inventory (what you've measured) to your book inventory (what your recordkeeping indicates you should have). Some people call this process inventory reconciliation. If the difference between your stick and book inventory is too large, your tank may be leaking.

EPA has a booklet, **Doing Inventory Control Right**, that fully explains how to do inventory control. The booklet also contains standard recordkeeping forms. You can order this free booklet by calling EPA's publication distributor at (800) 490-9198 or downloading it from EPA's web site at http://www.epa.gov/OUST/. See inside the front cover for full ordering information.

- UST inventories are determined each operating day by using a gauge stick and recording the data on a form. The level on the gauge stick is converted to a volume of product in the tank using a calibration chart, which is often furnished by the UST manufacturer.

- The amounts of product delivered to and withdrawn from the UST each operating day are also recorded. At least once each month, the gauge stick data and the sales and delivery data are reconciled and the month's overage or shortage is determined. If the overage or shortage is greater than or equal to 1.0 percent of the tank's flow-through volume plus 130 gallons of product, the UST may be leaking.

What are the regulatory requirements?

- Inventory control must be used in combination with periodic tank tightness tests.

- The gauge stick should reach the bottom of the tank and be marked so that the product level can be determined to the nearest one-eighth of an inch. A monthly measurement should be taken to identify any water at the bottom of the tank.

- Product dispensers must be calibrated to the local weights and measures standards.

Anything else you should consider?

- Inventory control is a practical, commonly used management tool that does not require closing down the tank operation for long periods.

- The accuracy of tank gauging can be greatly increased by spreading product-finding paste on the gauge stick before taking measurements (or by using in-tank product level monitoring devices).

- If your tank is not level, inventory control may need to be modified. You will need to get a corrected tank chart.

Time restrictions on the use of this combined method...

The combined method using tank tightness testing every 5 years is valid only after the entire UST system has met spill, overfill, and corrosion protection standards. Following entire UST system upgrade, this combined method may be used for 10 years after the date the tank was installed or upgraded with corrosion protection. Note that the end date is based on the compliance status of the ***tank only***, not the entire UST system. As a result, some USTs may not be able to use this combined method for as long as 10 years (see discussion below). At the end of the valid time period, you must use one of the monthly monitoring leak detection choices described in this booklet.

The combined method can be used only temporarily. Be sure you know how long you can use the combined method to meet federal, state, or local requirements.

Unique time restriction for some USTs...

For some USTs which had corrosion protection ***before*** the entire UST system met upgrade standards—this combined method of inventory control and tightness testing every 5 years may be valid for less than 10 years.

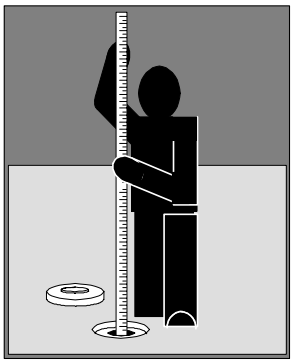
Federal regulations state that the combined method can be used: 1) 10 years after the tank is protected from corrosion, and 2) the period of validity cannot begin until the entire UST system meets upgrade standards. Therefore, in those cases where the tank had corrosion protection before the UST system met upgrade standards, the period of validity is less than 10 years. The effect of this restriction will be clear in the following example: a bare steel tank upgraded with corrosion protection in 1986 (or the tank was made of noncorrodible material and installed in 1986), but the piping, spill, and overfill upgrades were not added until 1995. The UST system in this example could start using the combined method only in 1995 (when the full system met upgrade standards) and could use the combined method only until 1998 (the date which is the later of either 1998 or 10 years after the tank has corrosion protection). In this example, the UST may use the combined method to meet federal leak detection requirements only for three years (from 1995 to 1998).

Correspondingly, when the period of validity is less than 10 years, fewer periodic tightness tests may be required.

Check with your implementing agency for guidance.

Manual Tank Gauging

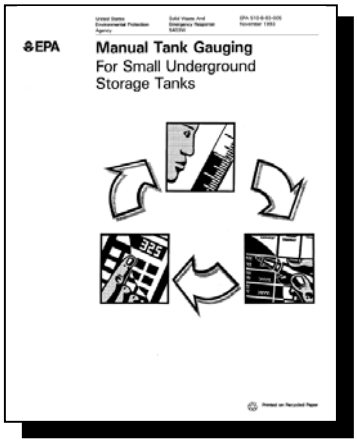
Will you be in compliance?



NOTE: ***Manual tank gauging can be used only on tanks 2,000 gallons or less capacity.*** *Tanks 1,000 gallons or less can use this method alone. Tanks from 1,001-2,000 gallons can temporarily use manual tank gauging only when it is combined with tank tightness testing. Manual tank gauging cannot be used on tanks over 2,000 gallons.* When performed according to recommended practices, manual tank gauging meets the federal leak detection requirements for USTs with a capacity of 1,000 gallons or less for the life of the tank. Manual tank gauging detects leaks only from ***tanks*** (this method does not detect piping leaks). For requirements for piping, see the section on leak detection for piping starting on page 22.

How does the leak detection method work?

EPA has a booklet, **Manual Tank Gauging**, that fully explains how to do manual tank gauging correctly. The booklet also contains standard recordkeeping forms. You can order this free booklet by calling EPA's publication distributor at (800) 490-9198 or downloading it from the EPA web site at http://www.epa.gov/OUST/. See inside the front cover for complete ordering information.



- Four measurements of the tank's contents must be taken weekly, two at the beginning and two at the end of **at least a 36-hour period** during which nothing is added to or removed from the tank. See the table on the next page.

- The average of the two consecutive ending measurements are subtracted from the average of the two beginning measurements to indicate the change in product volume.

- Every week, the calculated change in tank volume is compared to the standards shown in the table on the next page. If the calculated change exceeds the weekly standard, the UST may be leaking. Also, monthly averages of the four weekly test results must be compared to the monthly standard in the same way. See the table on the next page.

What are the regulatory requirements?

- Liquid level measurements must be taken with a gauge stick that is marked to measure the liquid to the nearest one-eighth of an inch.

- Manual tank gauging may be used as the sole method of leak detection for tanks with a capacity of 1,000 gallons or less for the life of the tank. Tanks between 551 and 1,000 gallons have testing standards based on their diameter or their additional use of tightness testing (see table). These tanks may temporarily use a combination of manual tank gauging and periodic tank tightness (see next bullet on page 21).

Table of Test Standards for Manual Tank Gauging

Tank Size	Minimum Duration Of Test	Weekly Standard (1 test)	Monthly Standard (4-test average)
up to 550 gallons	36 hours	10 gallons	5 gallons
551-1,000 gallons (when tank diameter is 64")	44 hours	9 gallons	4 gallons
551-1,000 gallons (when tank diameter is 48")	58 hours	12 gallons	6 gallons
551-1,000 gallons (also requires periodic tank tightness testing)	36 hours	13 gallons	7 gallons
1,001-2,000 gallons (also requires periodic tank tightness testing)	36 hours	26 gallons	13 gallons

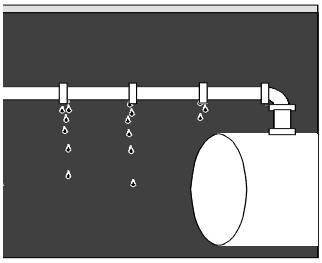
- For tanks with a capacity of 1,001-2,000 gallons, manual tank gauging must be combined with periodic tightness testing. This combined method will meet the federal requirements only ***temporarily***. See page 19 for an explanation of time restrictions that also applies to the combination of manual tank gauging and tank tightness testing. You must eventually have another monitoring method that can be performed at least once a month. See the other sections of this booklet for allowable monthly monitoring options. Also, see pages 16-17 on tank tightness testing for details on this method.

- Tanks greater than 2,000 gallons in capacity may not use this method of leak detection to meet these regulatory requirements.

Anything else you should consider?

- You can perform manual tank gauging yourself. Correct gauging, recording, and math are the most important factors for successful tank gauging. The accuracy of tank gauging can be greatly increased by spreading product-finding paste on the gauge stick before taking measurements.

Leak Detection For Underground Piping



Will you be in compliance?

When installed and operated according to the manufacturer's specifications, the leak detection methods discussed here meet the federal regulatory requirements for the life of underground piping systems. Your UST may have ***suction*** or ***pressurized*** piping, which are discussed below.

What are the regulatory requirements for suction *piping?*

- No leak detection is required if the suction piping has (1) enough slope so that the product in the pipe can drain back into the tank when suction is released and (2) has only one check valve, which is as close as possible beneath the pump in the dispensing unit. If a suction line is to be considered exempt based on these design elements, there must be some way to check that the line was actually installed according to these plans.

- If a suction line does not meet all of the design criteria noted above, one of the following leak detection methods must be used:

  - A line tightness test at least every 3 years; or

  - Monthly interstitial monitoring; or

  - Monthly vapor monitoring (including tracer compound analysis); or

  - Monthly groundwater monitoring; or

  - Monthly statistical inventory reconciliation; or

  - Other monthly monitoring that meets performance standards.

The line tightness test must be able to detect a leak at least as small as 0.1 gallon per hour at 1.5 times normal operating pressure with certain probabilities of detection and of false alarm.

Interstitial monitoring, vapor monitoring (including tracer compound analysis), groundwater monitoring, and statistical inventory reconciliation have the same regulatory requirements for piping as they do for tanks. See the earlier sections of this booklet on those methods.

What are the regulatory requirements for pressurized *piping?*

Each pressurized piping run must have one leak detection method from each set below:

An automatic line leak detector:

- Automatic flow restrictor; or
- Automatic flow shutoff; or
- Continuous alarm system.

And one other method:

- Annual line tightness test; or
- Monthly interstitial monitoring; or
- Monthly vapor monitoring (including tracer compound analysis); or
- Monthly groundwater monitoring; or
- Monthly statistical inventory reconciliation; or
- Other monthly monitoring that meets performance standards.

Find out if there are state or local requirements on the use of leak detection methods for piping that differ from those described here.

- The automatic line leak detector (LLD) must be designed to detect a leak at least as small as 3 gallons per hour at a line pressure of 10 pounds per square inch within 1 hour by shutting off the product flow, restricting the product flow, or triggering an audible or visual alarm.

- The line tightness test must be able to detect a leak at least as small as 0.1 gallon per hour when the line pressure is 1.5 times its normal operating pressure. The test must be conducted each year. If the test is performed at pressures lower than 1.5 times operating pressure, the leak rate to be detected must be correspondingly lower.

- Automatic LLDs and line tightness tests must also be able to meet the federal regulatory requirements regarding probabilities of detection and false alarm.

- Interstitial monitoring, vapor monitoring (including tracer compound analysis), groundwater monitoring, and statistical inventory reconciliation have the same regulatory requirements for piping as they do for tanks. See the earlier sections of this booklet on those methods.

How do the leak detection methods work?

Automatic line leak detectors (LLDs)

- Flow restrictors and flow shutoffs can monitor the pressure within the line in a variety of ways: whether the pressure decreases over time; how long it takes for a line to reach operating pressure; and combinations of increases and decreases in pressure.

- If a suspected leak is detected, a *flow restrictor* keeps the product flow through the line well below the usual flow rate. If a suspected leak is detected, a *flow shutoff* completely cuts off product flow in the line or shuts down the pump.

- A *continuous alarm system* constantly monitors line conditions and immediately triggers an audible or visual alarm if a leak is suspected. Automated internal, vapor, or interstitial line monitoring systems can also be set up to operate continuously and sound an alarm, flash a signal on the console, or even ring a telephone in a manager's office when a leak is suspected.

- Both automatic flow restrictors and shutoffs are permanently installed directly into the pipe or the pump housing.

- Vapor, interstitial, or other monitoring systems can be installed to shut off flow, restrict flow, or trigger an alarm whenever a leak is detected. If it meets the applicable standards, such a setup meets the monthly monitoring requirement as well as the LLD requirement.

Line tightness testing

- The line is taken out of service and pressurized, usually above the normal operating pressure. A drop in pressure over time, usually an hour or more, suggests a possible leak.

- Suction lines are not pressurized very much during a tightness test (about 7 to 15 pounds per square inch).

- Most line tightness tests are performed by a testing company. You just observe the test.

- Some *tank* tightness test methods can be performed to include a tightness test of the connected piping.

- For most line tightness tests, no permanent equipment is installed.

- In the event of trapped vapor pockets, it may not be possible to conduct a valid line tightness test. There is no way to tell definitely before the test begins if this will be a problem, but long complicated piping runs with many risers and dead ends are more likely to have vapor pockets.

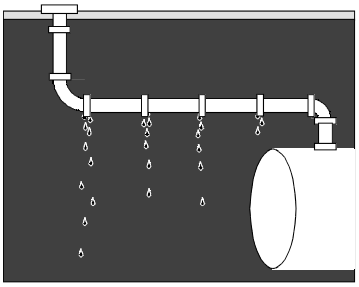
- Some permanently installed electronic systems (which often include ATGS) can meet the requirements of monthly monitoring or a line tightness test.

Secondary containment with interstitial monitoring

- A barrier is placed between the piping and the environment. Double-walled piping or a leakproof liner in the piping trench can be used.
- A monitor is placed between the piping and the barrier to sense a leak if it occurs. Monitors range from a simple stick that can be put in a sump to see if a liquid is present, to continuous automated systems that monitor for the presence of liquid product or vapors.
- Proper installation of secondary containment is the most important and the most difficult aspect of this leak detection method. Trained and experienced installers are necessary.
- See the section on secondary containment for additional information. Secondary containment for piping is similar to that for tanks.

Vapor (including tracer compound analysis) or groundwater monitoring

- Vapor monitoring detects product that leaks into the soil and evaporates.
- Tracer compound analysis uses a tracer chemical to determine if there is a hole in the line.
- Groundwater monitoring checks for leaked product floating on the groundwater near the piping.
- A site assessment must be used to determine monitoring well placement and spacing.
- UST systems using vapor (including tracer compound analysis) or groundwater monitoring for the tanks are well suited to use the same monitoring method for the piping.
- See the earlier sections on vapor (including tracer compound analysis) and groundwater monitoring. Use of these methods with piping is similar to that for tanks.



Publications About UST Requirements

Available Free... You can go to our web site at **http://www.epa.gov/oust/pubs/index.htm** to order or download documents online. You can write and ask for titles by addressing your request to NSCEP, our publication distributor: NSCEP, Box 42419, Cincinnati, OH 45242. Or you can make your request by calling NSCEP's toll-free number at (800) 490-9198. Or you can fax your order to NSCEP at (513) 489-8695.

Titles

Musts For USTs: A Summary Of Federal Regulations For Underground Storage Tank Systems
Booklet clearly summarizes federal UST requirements for installation, release detection, spill, overfill, and corrosion protection, corrective action, closure, reporting and recordkeeping. Updated & revised 1995 (36 pages). Also available as **Normas y Procedimientos para T.S.A.**,Spanish translation of 1988 edition of **Musts For USTs** (40 pages).

Automatic Tank Gauging Systems For Release Detection: Reference Manual For Underground Storage Tank Inspectors
Manual helps state and EPA UST inspectors evaluate how well owners and operators are using their automatic tank gauging (ATG) systems to comply with release detection requirements. Contains a summary of specifications, based on third-party evaluations, for ATG systems that detect leaks from USTs and their piping (140 pages).

Operating and Maintaining Underground Storage Tank Systems: Practical Help and Checklists
Manual provides brief summaries of federal UST requirements for operation and maintenance (O&M), as well as practical help that goes beyond the requirements. Contains checklists, recordkeeping forms, and information to help owners and operators properly operate and maintain their USTs (50 pages).

Model Underground Storage Tank Environmental Results Program Workbook
Workbook, which states can modify to reflect their laws, helps improve owner and operator compliance with UST regulations. Contains general information about ERP; instructions on how to use the workbook; regulatory requirements, best management practices, and compliance checklists for USTs; and draft forms and worksheets in the appendices (164 pages).

UST Systems: Inspecting and Maintaining Sumps and Spill Buckets – Practical Help and Checklist
Manual presents recommended inspection guidelines and best management practices for UST system sumps and spill buckets. Includes safety considerations; a general introduction to the kinds of sumps; basic maintenance procedures for sumps and spill buckets; and a sump and spill bucket inspection checklist (16 pages).

Doing Inventory Control Right: For Underground Storage Tanks
Booklet describes how owners and operators of USTs can use inventory control and periodic tightness testing to meet federal leak detection requirements. Contains reporting forms (16 pages).

Manual Tank Gauging: For Small Underground Storage Tanks
Booklet provides simple, step-by-step directions for conducting manual tank gauging for tanks 2,000 gallons or smaller. Contains reporting forms (12 pages).

Introduction To Statistical Inventory Reconciliation: For Underground Storage Tanks
Booklet describes how Statistical Inventory Reconciliation (SIR) can meet federal leak detection requirements (12 pages).

Closing Underground Storage Tanks: Brief Facts
Trifold leaflet presents "brief facts" on properly closing USTs in order to comply with federal closure requirements.

Dollars And Sense: Financial Responsibility Requirements For Underground Storage Tanks
Booklet summarizes the "financial responsibility" required of UST owners and operators (16 pages).

Financing Underground Storage Tank Work: Federal And State Assistance Programs
Booklet identifies potential sources of financial assistance to cover the costs of upgrading, replacing, or closing an UST, or of cleaning up an UST release (30 pages).

Videos About UST Requirements

There are several helpful videos you can order as explained below. Contacts can provide information about availability and cost.

Video Title	Contact
Tank Closure Without Tears: An Inspector's Safety Guide Focuses on explosive vapors and safe tank removal (30 minutes). **What Do We Have Here?: An Inspector's Guide To Site Assessment At Tank Closure** Inspecting sites for contamination where tanks have been removed. Part 1: Site Assessment Overview (30 minutes); Part 2: Field Testing Instruments At A Glance (14 minutes); Part 3: Soil And Water Sampling At A Glance (7 minutes). **Searching For The Honest Tank: A Guide To UST Facility Compliance Inspection** Covers major aspects of UST inspections, including protocols, equipment, cathodic protection, and leak detection. Directed at inspectors, yet also helpful to owners and operators (30 minutes).	**New England Interstate Water Pollution Control Commission** Attn: Videos 116 John Street Lowell, MA 01852 (978) 323-7929
Tank Time Humorous presentation explains what UST owners and operators must do to comply with the December 1998 deadline to upgrade, replace, or close tanks installed before December 1988 (18 minutes).	**Scene Three, Inc.** 2600 Franklin Road Nashville, TN 37204 (615) 345-3000
Doing It Right Illustrates proper installation of underground tanks and piping for installation crews. Part 1: Tanks (24 minutes); Part 2: Piping (16 minutes). **Doing It Right II: Installing Required UST Equipment** Illustrates installation of spill and overfill equipment, observation wells, and piping leak detection (23 minutes). **Keeping It Clean: Making Safe And Spill-Free Motor Fuel Deliveries** Making pollution-free deliveries to USTs. Includes Stage 1 vapor recovery, overfill prevention and spill containment. For fuel tanker drivers and UST owner/operators (25 minutes). **Petroleum Leaks Underground** How liquids and vapors move in the subsurface and why early response to leaked petroleum is so important. Part 1: How Liquids Move (14 minutes); Part 2: How Vapors Move (15 minutes). **Straight Talk on Leak Detection** Overview of the leak detection methods available for complying with federal regulations (30 minutes). **RBCA: Initial Site Assessment** Overview of risk-based corrective action process produced by Shell Oil Company (25 minutes).	**EPA's Office of Underground Storage Tanks** (703) 603-9900 or visit EPA's web site at www.epa.gov/oust/oustcont.htm (see videos)

State Regulatory Agency Contacts

See EPA's web site at http://www.epa.gov/oust/states/statcon1.htm for state underground storage tank program contact information.

United States
Environmental Protection
Agency

Solid Waste And
Emergency Response
5401G

EPA 510-B-05-001
September 2005
www.epa.gov/oust/pub