North Carolina Department of
Environmental Quality
Underground Storage Tank Section

Leak Detection Methods for Petroleum Underground Storage Tanks and Piping

(If installed prior to November 1, 2007)

October 2015

This document is a reformatted version of the U.S. EPA manual EPA 510-B-97-007, "Straight Talk on Tanks: Leak Detection Methods for Petroleum Underground Storage Tanks," September 1997. It has been updated to incorporate North Carolina's specific requirements for performing leak detection for tanks and piping. The UST Section gratefully acknowledges the EPA's willingness to allow us to customize this document.

Contents

Free Publications about UST Requirements

You can go to N.C. USTs Web Site at **http://www.wastenotnc.org/web/wm/ust/ustmain** to read or download documents online or you can contact one of the N.C. DEQ offices listed on page 28 to order copies. Also, you can go to EPA's UST Web Site at **http://www.epa.gov/OUST/pubs/index.htm** to order or read documents online or call EPA's publication distributor **toll-free** at 800-490-9198. You may order **up to 30 free copies** of any title.

Do You Have Questions About Leak Detection?

Note: This manual is only for UST systems and components installed prior to November 1, 2007.

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 **NOW**.

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

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

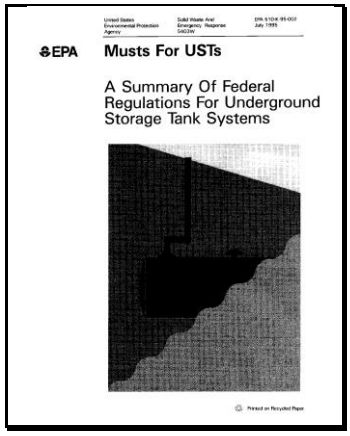
You will find the answers here for many basic questions about how leak detection methods work and which methods are best for your UST site.

Why is leak detection so important?

As of March 1997, almost 330,000 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. You can order a free copy of this booklet by calling EPA's publication distributor at 800 490-9198 (see the contents page for full ordering information).



An Overview of Leak Detection Requirements

All new USTs (those installed after December 1988) must have leak detection when they are installed.

USTs installed before December 1988 (called "existing USTs") had compliance deadlines for leak detection phased in over five years.

By December 1993, all "existing 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
- Vapor Monitoring
- Groundwater Monitoring
- Statistical Inventory Reconciliation
- Other Methods Meeting Performance Standards

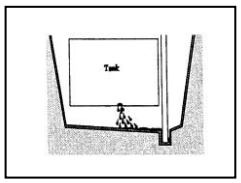
Note: All UST Systems and components installed on or after November 1, 2007 must use Secondary Containment with Interstitial Monitoring conducted in accordance with 15A NCAC 2N .0900

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.

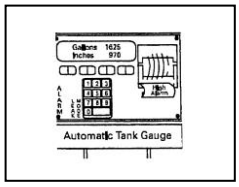
Brief descriptions of leak detection methods appear on the next two pages. More complete descriptions appear in the following sections.

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



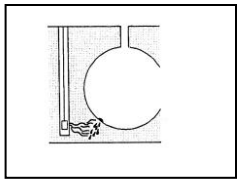
Secondary containment often uses a barrier, an outer wall, a vault, or a liner around the UST or piping. Tanks can be equipped with inner bladders that provide secondary containment. Leaked product from the inner tank or piping is directed towards an "interstitial" monitor located between the inner tank or piping and the outer barrier. Interstitial monitoring methods range from a simple dipstick to a continuous, automated vapor or liquid sensor permanently installed in the system.

- **Automatic Tank Gauging Systems (see pages 8-9)**



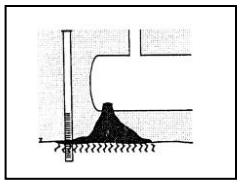
A probe permanently installed in the tank is wired to a monitor to provide information on product level and temperature. These systems automatically calculate the changes in product volume that can indicate a leaking tank.

- **Vapor Monitoring (see pages 10-11)**



Vapor monitoring measures product "fumes" in the soil around the UST 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.

- **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 550 gallons. Tanks between 551 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.

Look For the "Proof" Of A Third-Party Evaluation

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.

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 "results" form and, when provided, its "description" form. You should obtain these forms from the leak detection vendor and keep them on file. They contain 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 two hours or more, then your UST must be tested for at least two 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?

A list of leak detection systems that have been evaluated by third parties can be found at: http://www.nwglde.org.

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.

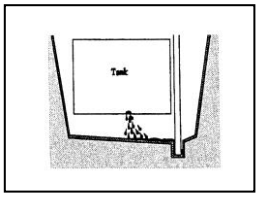
Identifying the best leak detection choice for your UST depends on a number of factors including cost (both initial installation cost and long-term operation and maintenance cost), facility configuration (such as complexity of piping runs and manifolded tanks), groundwater depth, soil type, seasonal 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 your local N.C. DEQ Regional Office. (See the N.C. DEQ contacts list on page 28.)

The U.S. EPA provides a free publication**, "**List Of Leak Detection Evaluations for UST Systems,**"** that contains a detailed summary of specifications, based on third-party evaluations, for over 250 leak detection systems. (See inside the front cover for ordering information.) Additionally, a list of equipment with approved third-party evaluations can be found at **http://www.nwglde.org/**.

For additional information about federal UST requirements, contact EPA's RCRA/Superfund Hotline at 800 424-9346.

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 state and 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 ("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 a change in the level of a monitoring liquid 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.

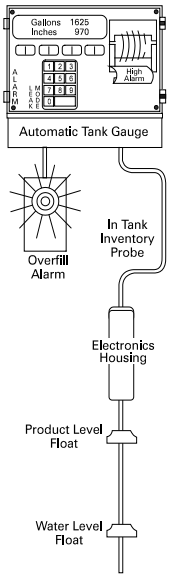
Will it work at your site?

- 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 state and 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.

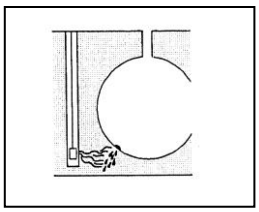
Will it work at your site?

- ATGS have been used primarily on tanks containing gasoline or diesel, with a capacity of up to 15,000 gallons. If considering using an ATGS for larger tanks or products other than gasoline or diesel, discuss its applicability with the manufacturer's representative.
- 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. Each tank at a site must be equipped with a separate probe.
- 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 six hours before the monthly test or during the test (which generally takes one to six hours).
- An ATGS can be programmed to perform a test more often than once per month (a recommended practice).

Vapor Monitoring



Will you be in compliance?

When installed and operated according to the manufacturer's instructions, vapor monitoring meets state and federal leak detection requirements for USTs. Operation of a vapor monitoring system at least once every 14 days 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.
- 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.
- 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 every 14 days to monitor a site.
- All vapor monitoring devices should be periodically calibrated according to the manufacturer's instructions to ensure that they are properly responding.
- 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 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

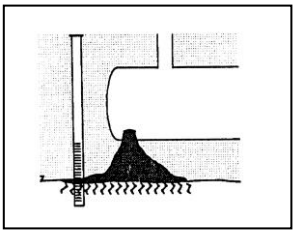
What are the regulatory requirements?

- The UST backfill must be sand, gravel or another material that will allow the vapors 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.

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 state and federal leak detection requirements for USTs. Operation of a groundwater monitoring system at least once every 14 days 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 every 14 days 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.
- Detection devices are also available in manual form. Manual devices range from a bailer (used to collect a liquid sample for testing) 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 every 14 days.
- 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.

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

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 them 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.

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 state and 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.)

You can order a free booklet, Introduction to Statistical Inventory Reconciliation, that describes the use of this method. See the contents page for ordering information.

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.
- 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.

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, an 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 an 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.

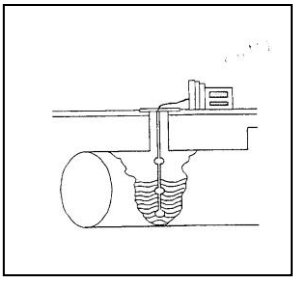
Will it work at your site?

- SIR has been used primarily on tanks no more than 18,000 gallons in capacity. If you are considering using a SIR method for larger tanks, check the method's evaluation to confirm that it will meet regulatory requirements and your needs.
- An 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.

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 state and 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 state and 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. Other terms used for these methods include "precision," "volumetric" and "nonvolumetric" testing.
- Many tightness test methods are "volumetric" methods in which the change in product level in a tank over time is measured very precisely (in milliliters or thousandths of an inch).
- Other methods use acoustics or tracer chemicals to determine the presence of a hole in the tank. With such methods, all of the factors in the following bullets may not apply.
- For most methods, 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.
- For most methods, a net decrease in product volume (subtracting out volume changes caused by temperature) over the time of the test indicates a leak.
- 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.
- Many test methods require that the product in the tank be a certain level before testing, which often requires adding product from another tank on-site or purchasing additional product.

- Some tightness test methods require all of the measurements and calculations to 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.
- A few methods measure properties of the product that are independent of temperature, such as the mass of the product, and so do not need to measure product temperature.
- Some automatic tank gauging systems are capable of meeting the regulatory requirements for tank tightness testing and can be considered as an equivalent method.

What are the regulatory requirements?

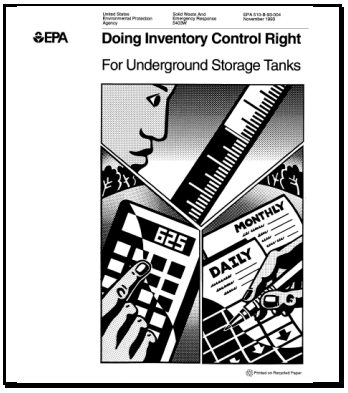
- The tightness test method must be able to detect a leak at least as small as 0.1 gallon per hour with certain probabilities of detection and of false alarm.
- Tightness tests must be performed periodically. New UST systems - those installed after December 1988 - must have tank tightness tests every 5 years for 10 years following installation. In most cases, existing UST systems-those installed before December 1988 - that have spill, overfill, and corrosion protection must have tank tightness tests every 5 years for 10 years following upgrade. See page 19 for some cases requiring fewer tightness tests.
- After the applicable time period noted above, 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.
- Tank tightness testing has been used primarily on tanks no more than 15,000 gallons in capacity containing gasoline and diesel. If you are considering using tightness testing for larger tanks or products other than gasoline or diesel, discuss the method's applicability with the manufacturer's representative.
- 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.

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 record-keeping 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 record-keeping forms. You can order this free booklet by calling EPA's toll-free Hotline at 800 490-9198. See the contents page for full ordering information. Or you can contact your local N.C. DEQ Regional Office. See page 28 for contact 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 (or until December 1998, whichever is later) 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 only be used temporarily. Be sure you know how long you can use the combined method to meet state and federal requirements.

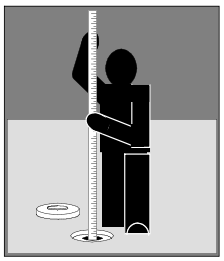
Unique time restriction for some existing USTs...

For some existing USTs - those 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) until December 1998 or 10 years after the tank is protected from corrosion (whichever date is later), 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 state and 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.

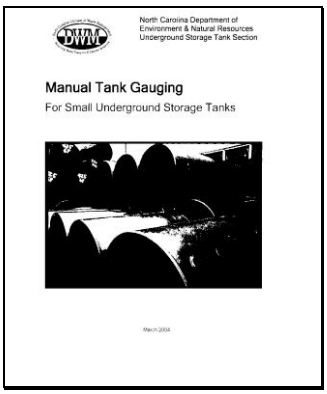
Manual Tank Gauging



Will you be in compliance?

NOTE: **Manual tank gauging can be used only on tanks 2,000 gallons or less capacity.** *Tanks 550 gallons or less can use this method alone. Tanks from 551-2,000 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 state and federal leak detection requirements for USTs with a capacity of 550 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?



N.C. DEQ 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 obtain a free booklet by contacting your local N.C. DEQ Regional Office (See page 28 for contact information) or you can download a copy from our Web site by visiting **http://www.wastenotnc.org/web/wm/ust/pibfaq#MAN**

- 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 beginning measurements are subtracted from the average of the two ending 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 550 gallons or less for the life of the tank. Tanks between 551 and 2,000 gallons may temporarily use a combination of manual tank gauging and periodic tank tightness testing. (See the next bullet on page 21.)

Table of Test Standards for Manual Tank Gauging

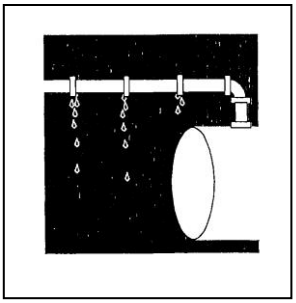
Tank Size	Minimum Duration Of Test	Weekly Standard (1 test)	Monthly Standard (4-test average)
up to 550 gallons	36 hours	10 gallons	5 gallons
551-1000 gallons (also requires periodic tank tightness testing)	36 hours	13 gallons	7 gallons
1001-2000 gallons (also requires periodic tank tightness testing)	36 hours	26 gallons	13 gallons

- For tanks with a capacity of 551-2,000 gallons, manual tank gauging must be combined with periodic tightness testing. This combined method will meet state and 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 state and 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?

Note: All UST Systems and components installed on or after November 1, 2007 must use Secondary Containment with Interstitial Monitoring conducted in accordance with 15A NCAC 2N .0900

- 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 three years; or
  - Monthly interstitial monitoring; or
  - Semi-Monthly vapor monitoring; or
  - Semi-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, 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
- Semi-Monthly vapor monitoring; or
- Semi-Monthly groundwater monitoring; or
- Monthly statistical inventory reconciliation; or
- Other monthly monitoring that meets performance standards.

- 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, 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.

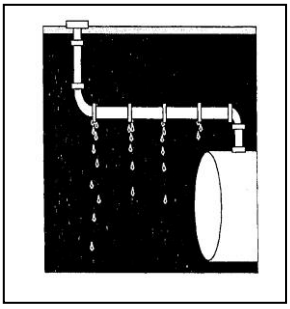
Line tightness testing

- Tracer methods do not measure pressure or flow rates of the product. Instead they use a tracer chemical to determine if there is a hole in the line. With tracer methods, all of the factors below may not apply.
- 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 or groundwater monitoring



- Vapor monitoring detects product that leaks into the soil and evaporates.
- 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 or groundwater monitoring for the tanks are well suited to use the same monitoring method for the piping.
- See the earlier sections on vapor and groundwater monitoring. Use of these methods with piping is similar to that for tanks.

Free Publications about UST Requirements

AVAILABLE FREE...There are several ways to obtain documents. You can contact one of the N.C. DENR offices listed on page 28 or go to the UST Web site located at **http://www.wastenotnc.org/web/wm/ust/ustmain** to download or read documents online. You can also go to EPA's Web site at **http://www.epa.gov/OUST/** to order or read documents online or call EPA's publication distributor at 800 490-9198 and order **up to 30 free copies**.

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).

Leak Detection Methods for Petroleum Underground Storage Tanks
Booklet explains state and federal regulatory requirements for leak detection and briefly describes allowable leak detection methods. Updated & revised 10/2013 (28 pages). **Only available from DEQ offices listed on page 28 or visit http://www.wastenotnc.org/web/wm/ust/pibfaq#MAN**

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. Updated & revised 10/2013 (12 pages). **Only available from DEQ offices listed on page 28 or at http://www.wastenotnc.org/web/wm/ust/pibfaq#MAN**

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

Don't Wait Until 1998: Spill, Overfill, And Corrosion Protection For Underground Storage Tanks
Information to help owners and operators of USTs meet the 1998 deadline for compliance with requirements to upgrade, replace, or close USTs installed before December 1988. Materials available as a 16-page booklet, a trifold leaflet, or Spanish translation of the booklet (No Espere Hasta El 1998!).

Are You Upgrading An Underground Storage Tank System?
Trifold leaflet can help UST owners and operators make sound decisions about choosing tank integrity assessment methods and upgrading USTs to meet 1998 deadline requirements.

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).

An Overview Of Underground Storage Tank Remediation Options
Information about technologies for remediating petroleum contamination in soil and groundwater (26 pages).

Controlling UST Cleanup Costs
Fact sheet series on the cleanup process includes: Hiring a Contractor, Negotiating the Contract, Interpreting the Bill, Managing the Process, and Understanding Contractor Code Words (10 pages).

Pay-For-Performance Cleanups: Effectively Managing Underground Storage Tank Cleanups
Booklet explores potential advantages of using pay-for-performance cleanup agreements to reduce the cost and time of cleanups and more effectively manage cleanup resources (32 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, at cost, as explained below:

TITLE/COST	AVAILABLE FROM
Tank Closure Without Tears: An Inspector's Safety Guide Focuses on explosive vapors and safe tank removal (30 minutes). Video and Booklet **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). Video and Booklet **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). Video and Booklet	**NEIWPCC** Wannalancit Mills 650 Suffolk St., Ste. 410 Lowell, MA 01854 978.323.7929 http://www.neiwpcc.org
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.** ATTN: "Tank Time" 2600 Franklin Pike 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). **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).	**Contact EPA's Hotline at 800.490-9198 for cost and ordering information.**

North Carolina Department of Environmental Quality
Division of Waste Management
UST Section Central Office
1646 Mail Service Center
Raleigh, NC 27699-1646
(919) 707-8171 FAX (919) 715-1117
http://www.wastenotnc.org/web/wm/