United States Environmental Protection Agency

Office of Underground Storage Tanks

General Guidance For Using EPA's Standard Test Procedures For Evaluating Release Detection Methods

May 2019

Acknowledgments

The U.S. Environmental Protection Agency's Office of Underground Storage Tanks contracted with Battelle under Contract No. EP-C-10-001 to develop this document. It is based largely on 1990 documents written by Midwest Research Institute, Vista Research, and Radian. Individual members of the National Work Group on Leak Detection Evaluations, as well as Ken Wilcox and Associates, reviewed this document and provided technical assistance. A stakeholder committee, comprised of approximately 50 representatives from release detection method manufacturers and various industry associations, commented on this document.

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List Of Acronyms And Abbreviations

ASTM International	American Society for Testing and Materials International
ATGS	automatic tank gauging system
B	bias
CFR	Code of Federal Regulations
CITLDS	continuous in-tank leak detection system
EPA	U.S. Environmental Protection Agency
gal/hr	gallon per hour
NWGLDE	National Work Group on Leak Detection Evaluations
OUST	Office of Underground Storage Tanks
P(d)	probability of detecting a leak
P(fa)	probability of false alarm
R	leak rate
SIR	statistical inventory reconciliation
Th	threshold
TTT	tank tightness testing
UST	underground storage tank

Section 1: Demonstration Of Performance Standards

The federal underground storage tanks (UST) regulation in 40 Code of Federal Regulations (CFR) Part 280 specifies performance standards for release detection methods. UST owners and operators must demonstrate that the release detection method they use meets the U.S. Environmental Protection Agency's (EPA) regulatory performance standards. This guidance provides an overview of the standard test procedures so UST owners and operators can evaluate test procedures best suited to their facility; discusses ways owners and operators can determine whether their release detection methods meet federal regulatory requirements; and describes a process for using the standard test procedures to evaluate release detection methods. UST implementing agencies may have additional requirements for approving the use of release detection methods. Check with the UST implementing agency where your UST system is located to ensure you meet all applicable requirements.

The large number of commercially available release detection methods makes it impossible for EPA to test all methods or to review all performance claims. EPA does not test, certify, or approve specific brands of commercial release detection methods. Rather, EPA describes how a method should be tested to prove that it meets performance standards. Vendors, in conjunction with evaluating organizations, are responsible for testing methods.

EPA recognizes three ways to prove that a release detection method meets the federal performance standards:

- Evaluate the method using EPA's standard test procedures for release detection methods
- Evaluate the method using a national consensus code or standard developed by a nationally-recognized association or independent testing laboratory
- Evaluate the method using an alternative procedure deemed equivalent to an EPA standard test procedure by a nationally-recognized association or independent testing laboratory

The vendor should prove the release detection method meets the regulatory performance standards using one of three ways described below. For regulatory enforcement purposes, each way is equally satisfactory.

1.1 EPA Standard Test Procedures

In 1990, EPA developed a series of seven standard test procedures that covered the most commonly used UST release detection methods. Over the years, new methods became available and other fuels were being stored in and dispensed from USTs; therefore, in 2019 EPA updated the standard test procedures and consolidated them into four main categories. They are:

- *Standard Test Procedures For Evaluating Release Detection Methods: Automatic Tank Gauging Systems*
- *Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection*

- *Standard Test Procedures For Evaluating Release Detection Methods: Statistical Inventory Reconciliation*
- *Standard Test Procedures For Evaluating Release Detection Methods: Tank Tightness Testing - Volumetric And Non-volumetric*

The standard test procedures provide an explanation of how to conduct the evaluation tests, perform the required calculations, and report the results. The results from the standard test procedures provide information tank owners and operators need to determine if their release detection method meets the regulatory requirements.

Vendors or an independent evaluator on behalf of the vendor may conduct EPA's standard test procedures. Generally, regulatory authorities and UST owners and operators prefer that an independent evaluator carry out the evaluation to prove compliance with the regulation. Evaluations are more likely to be fair and objective if the evaluator is independent of the vendor. Independent evaluators may include consulting firms, test laboratories, not-for-profit research organizations, or educational institutions.

1.2 National Consensus Code Or Standard

Another way for a vendor to prove the performance of a release detection method is to evaluate the method following a national voluntary consensus code or standard developed by a nationally recognized association such as the American Society of Mechanical Engineers, American National Standards Institute, or ASTM International. Throughout the development of the 2015 UST regulation, EPA relied on national voluntary consensus codes to help tank owners and operators decide which methods and equipment are acceptable to meet various regulatory requirements. You can find information for developing voluntary consensus codes in the U.S. Department of Commerce *Procedures for the Development of Voluntary Product Standards* (15 CFR Part 10) and *Federal Participation in the Development and Use of Voluntary Consensus Standards and in Conformity Assessment Activities* (Office of Management and Budget Circular No. A-119).

1.3 Alternative Test Procedure Deemed Equivalent To EPA's Standard Test Procedures

There may be instances where existing EPA standard test procedures or national voluntary consensus codes or standards do not adequately cover a release detection method, particularly as new fuels and the methods and equipment designed to function with those fuels come to market. Additionally, vendors may have data that make it easier to evaluate the method another way. Vendors who want their methods tested, or who have already tested their methods according to a different procedure, must use a nationally-recognized association or independent laboratory such as Factory Mutual, National Sanitation Foundation, Underwriters Laboratory to develop or review that procedure. The association or laboratory's test conditions must be at least as rigorous as EPA's standard test procedures and the accreditation of the association or laboratory must be included in the evaluation.

These are the requirements for using an alternative test procedure:

- The evaluator tests the method both under a no-leak condition and an induced-leak condition with an induced leak rate as close as possible to or smaller than the performance standard. In the case of volumetric tank tightness testing (TTT), this will mean testing under a minimum of 0.0 gal/hr, 0.05 gal/hr, and 0.1 gal/hr leak rates. In the case of automatic tank gauging systems (ATGS), this will mean testing under a minimum of 0.0 gal/hr, 0.05 gal/hr, and 0.2 gal/hr leak rates.
- The evaluator must test the method under at least as many different environmental conditions as the corresponding EPA standard test procedures.
- The conditions under which the method is evaluated must be at least as rigorous as the conditions specified in the corresponding EPA test procedures. For example, in the case of volumetric TTT, the test must include a temperature difference between the delivered product and that already present in the tank, as well as account for deformation caused by filling the tank prior to testing. Additionally, when method performance is sensitive to stored product viscosity, the method's most rigorous viscosity of listed products must be evaluated.
- The evaluation results must contain the same information and be presented in the same format as EPA's reporting forms provided in the appendix of each EPA standard test procedure.
- The evaluation of the release detection method must include physical testing of a full-sized version of the release detection method; full disclosure of the experimental conditions under which the evaluation was performed, and the recommendation for use. An evaluation based solely on theory or calculation is insufficient.

1.4 Purpose And Intended Use Of This Document

This 2019 general guidance document includes background information, updates, and standardization of the original test procedures. This document:

- Reduces unnecessary duplication of information presented in the test procedures
- Provides general information applicable to all of the test procedures
- Presents and explains standard terminology
- Describes typical release detection methods and operating principles used by these methods
- Discusses common elements of the test procedures such as scope, test design, statistical calculations, and how reports are organized

Section 2: EPA Standard Test Procedures

This section briefly summarizes the overall design of the standard test procedures and provides guidance for using the procedures. This section also follows the process for proving that a release detection method meets the regulatory performance standards. Table 1 presents the context for release detection methods and standard test procedures, basic steps required, and identification of parties involved to prove regulatory compliance. The federal UST regulation establishes what owners and operators must do to use release detection methods with a proven level of performance.

EPA designed the standard test procedures to use the leak rate specified in the appropriate regulatory requirement. Vendors develop or improve on commercially available release detection methods. Evaluators collect the data to estimate performance in terms of leak rate, P(d), and P(fa) according to the method's abilities following the appropriate standard test procedures; both no-leak and induced-leak conditions are tested. Evaluators may use other leak rates, typically below but also above the regulatory standard. Once evaluators collect these data, they are analyzed, reported and presented in *Appendix B – Reporting Forms*, of the associated standard test procedure. For the volumetric and non-volumetric tank tightness testing procedures, reporting forms for volumetric methods are presented in Appendix B and reporting forms for non-volumetric methods are presented in Appendix C. These standard test procedures provide owners and operators with results proving the method they maintain and operate meets regulatory compliance.

Table 1. Roles And Responsibilities

Activity	Steps And Parties Involved
UST Regulation	EPA's UST regulation sets release detection performance criteria to prevent releases and protect the environment
Release Detection Methods	Vendors develop release detection methods
Standard Test Procedures	EPA provides test procedures for evaluating method performance level to meet regulation
Testing	Evaluators collect data, perform statistical analyses, and prepare the reports
Method Listing (Optional)	National Work Group on Leak Detection Evaluations (NWGLDE) reviews the reports
	Release detection methods are listed as meeting regulatory performance standards

2.1 Regulatory Performance

The evaluator determines the specifications of method performance under the range of conditions the method was evaluated. The test procedures challenge the release detection method according to its abilities.

Method performance, in most cases, requires a P(d) and P(fa) at a defined leak rate. The P(d), or the probability of detecting a leak, is the number of times that a method would detect a leak of a specified size if there were such a leak. Thus, a P(d) of 95 percent, which may also be written as

0.95, suggests the method will correctly declare leaks of the specified size in 95 percent of systems tested. Missed detections, also referred to as false negatives, occur if the method fails to declare a leak when one is present; this occurs most frequently when the leak is small or changing due to such factors as head pressure in a tank or pipeline pressure and thermal expansion or contraction.

The P(fa), or probability of false alarm, is the proportion of tight, non-leaking UST systems that would be declared leaking if all the UST systems tested were tight. Thus, a P(fa) of 5 percent suggests the method will incorrectly declare leaks in 5 percent of the non-leaking systems tested.

The P(d), P(fa), method threshold (Th), and leak rates are all interrelated; changing one parameter affects the value of one or more of the other parameters. The choice of parameters affects the conclusions drawn from release detection tests, that is, the reliability of the test results. Once Th has been selected for each set of data analyzed, the P(fa) is determined and does not change, regardless of the leak rate to be detected. The P(d), however, does change with leak rate if Th is kept constant for each set of data analyzed. The P(d) increases as the leak rate increases, that is, there is a better chance of finding large leaks than small leaks. Th is usually chosen in such a way that P(d) and P(fa) present an acceptable balance between economic and environmental risks.

2.2 Release Detection Methods

Section 1.1 lists the four EPA standard test procedures for release detection methods. Table 2 presents the release detection categories and specific methods in each category. These methods represent the most common methods and operating principles in each category. Release detection methods are grouped as either volumetric or non-volumetric methods; in some cases, a method may apply to both categories. Owners and operators may use either type to satisfy requirements of 40 CFR 280 except when using statistical inventory control (SIR) methods. The primary distinction between the two categories is that volumetric methods report quantitative results, or a reported leak rate compared to Th, whereas non-volumetric methods report qualitative results, or only whether there is evidence of a leak or not.

Volumetric methods quantitatively measure leak rate from an UST, based on changes in liquid level in a tank. Various methods are available for measuring these changes, including floats, load cells, and ultrasonic devices. They can be further categorized into methods that meet 40 CFR 280 requirements for precision testing; 0.1 gal/hr leak rate, for example tank or pipeline tightness tests or a 0.2 gal/hr leak rate, for example ATGS or SIR respectively. Accurate use of each volumetric method requires knowledge of certain storage conditions and fuel properties, so you can adjust and compensate for other factors that might produce a change in liquid level. For example, you must know the coefficient of thermal expansion to correct the volume based on changes in the temperature of the stored product. Without this correction, a volume change that occurs as the storage temperature drops could be interpreted as a fuel leak or the actual calculated leak rate may be inaccurate. Other possible corrections include: fuel density based on temperature and ethanol content, air density based on temperature above the stored liquid, or groundwater level surrounding a tank.

Non-volumetric methods qualitatively identify when a leak is occurring in an UST. While you cannot use these methods to determine an actual leak rate in an UST system, the signal from the

methods indicates a tank might be leaking. Various non-volumetric methods include: acoustic measurements, water sensing equipment, and interstitial sensors. Examples of how these methods detect possible leaks are by detecting sounds made by fuel leaks through an opening in the tank shell, water present at the bottom of a tank, or liquids in the interstitial space of a double-walled tank. An indicator from one of these type methods cannot be used to calculate an exact volume or leak rate, but observing an indicator clearly shows the tank operator that the integrity of the tank shell may have been compromised. Other non-volumetric methods include vapor and liquid out-of-tank monitoring in the excavated soil area or groundwater surrounding an UST. Tracers can also be used to detect the presence of a leak.

Table 2. Summary Of Release Detection Methods And Operating Principles

Method	Principle Of Operation
Volumetric-Based Method Type	
Automatic Tank Gauge Systems (ATGS)	
Magnetostrictive Probes	Wire sensor inside a shaft detects presence of magnetic field, which indicates height of float.
Ultrasonic or Acoustic Methods (speed)	Sensor detects changes in fluid levels detecting a sound wave echo reflected from the interface of water and fuel or fuel and air; it calculates level based on speed of sound in the product.
Capacitance Probes	Detection is based on dielectric property of the stored liquid.
Mass Buoyancy And Measurement Systems	Buoyancy of probe is detected on a load cell and compared to tank geometry to calculate liquid level.
Statistical Inventory Reconciliation (SIR) Methods	
Traditional SIR	SIR vendor performs analysis of liquid level data for evidence of tank tightness. Data are collected by taking daily manual liquid level readings or using an ATGS.
Continuous SIR	SIR vendor software performs temperature compensation and leak-test calculations on data collected from designated input devices during tank quiet times. Also called continuous in tank leak detection system (CITLDS or CITLD).
Tank Tightness Testing	
Overfill	Product is added to tanks past levels of overfill prevention equipment typical settings.
Non-Volumetric Based Method Type	
Pipeline Methods (Piping)	
Pressure Decay	Measures the change in pressure between the atmosphere and the pressurized product in the line over time.
Constant Pressure	Sensors monitor change in volume at constant pressure.
Electronic Line Leak Detectors	Usually incorporate a microprocessor and feature precisely calibrated sensors that allow more sensitive tests on piping as compared to mechanical devices. Its detection element feeds data to a control panel that can trigger audible and visible alarms and even shut off a pump. The standard 3.0 gph test is performed after each dispensing activity.
Mechanical Line Leak Detectors	Pressure-operated valves typically installed on the head of the submersible pump. They perform a test of the piping each time the pump is turned on. Conducts leak tests every time the pump engages.
Tank Tightness Testing: Out of Tank Liquid and Vapor Monitoring Methods	
Fuel Sensitive Polymers	Fiber optic cable is coated with a polymer that interacts with fuel. When fuel is present, the light or current passing through the cable is affected.
Tracers	Chemical markers or tracers are added to the product and the surrounding soil is monitored for the tracers.

Method	Principle Of Operation
Acoustic Precision Test	Detected sounds are used to identify potential leaks; an orifice is used to simulate the sound produced as liquid or air leaks out of a system. This uses acoustic sensors and microphones, as well as ultrasonic sensors and hydrophones.
Vacuum And Pressure Decay Test	Determine tank tightness by the decay rate of the vacuum or pressure established by the method.
Tank Tightness Testing: Dry Interstitial Integrity Monitoring Methods	
Vacuum And Pressure Decay Monitoring	Method uses an integral vacuum pump or pressurized system to continuously maintain a partial vacuum or pressure within the interstitial space of double-walled tanks and double-walled piping. Method is capable of detecting breaches in both the inner and outer walls of double-walled tanks or double-walled piping.
Tank Tightness Testing: Wet Interstitial Integrity Monitoring Methods	
Liquid Filled	A liquid solution fills the tank or piping interstice. The dual-point level sensor system monitors the liquid level in the interstitial reservoir and sounds an alarm if the liquid level is either too high, which indicates ingress of liquid, or too low, which indicates egress of liquid. Method is capable of detecting breaches in both the inner and outer walls of double-walled tanks or double-walled piping.
Sensor – liquid ingress	Varies depending on the type of sensor; comes in multiple forms. Most examples include use of refractive index or float switch.
Tank Tightness Testing: Water Detection Methods (and ATGS component)	
Water Float	Buoyancy of float allows the magnetic field or capacitance signal generated to coincide with the top of the liquid layer; it is based on the liquid density in comparison to the float density. These floats are specifically designed for water detection and the density difference between water and the fuel product.
Density Float	Buoyancy of a float signals changes in product; it compares density data changes over time to assess the change in product quality due to water ingress. This float is sensitive to the aqueous phase detection found in ethanol-blended fuels.
Conductivity Water Probe	The probe detects water by measuring current flow when water contacts the probe; used with certain acoustic methods.

2.2.1 Automatic Tank Gauging Systems

ATGS are volumetric release detection methods. An ATGS relies on physical properties of the storage system to generate an electronic signal that can be converted into a value representing the volume in a tank. Manual tank gauging typically consists of sticking a long pole containing graduated length markings into an UST. An ATGS consists of a probe or sensor located inside the UST and a controller or console mounted in an indoor location. The probe or sensor generate the electronic signal that is subsequently processed in the console and calculates volume changes or leak rate. The electronic signal is generated in one of several ways, including:

- A float mounted to a probe; this is a liquid level method
- A set of acoustic sensors to detect sound in the liquid or the air space above the liquid; this is a sound transmission or reception method similar to sonar or radar
- A load cell suspended in the liquid product; this is a buoyancy method
- A set of sensors to determine the electrical properties of a liquid; this is an electric conductance or capacitance method

Regardless of the method employed, the signal generated by any of these methods is combined with a specific set of other data, which are recorded by the ATGS, and processed to calculate a volume of liquid in the UST. The console contains a processor that compares calculated volumes at different times, when the UST is not dispensing or receiving fuel, to determine if a difference is due to a leak or some other factor.

Depending on the ATGS, its data processor must correct the calculated volume for other method conditions. For example, the volume derived from the liquid height of a float system, electrical property, or acoustic sensor must be adjusted for liquid expansion or contraction produced by changes in temperature of the stored liquid. Similarly, to accurately calculate volume, the result obtained from a pressure, buoyancy, or sound velocity reading must incorporate a liquid or air density factor, which also varies with temperature. Given the proper inputs, the ATGS will yield information on volume of stored fuel and on calculated leak rates during a leak test. Most probes for ATGSs are also equipped with a water detection float.

2.2.2 Pipeline Release Detection

Pipeline release detection methods can be volumetric or non-volumetric methods. Both use similar operating principles and can be applied to testing both large pipelines such as those located at airport hydrant fueling systems and piping at typical UST facilities to meet, for example, the annual line tightness test requirement. These methods use fluid flow instrumentation to monitor flow rate of fluid moving through the underground piping of an UST system at one or more locations or the static pressure in a sealed pipe system. Flow measurement devices are usually based on pressure; however, these devices could also use a displacement piston or graduated cylinder instead of a pressure-based measurement device. The liquid within the piping is non-compressible and, therefore, a single flow measurement or a comparison of the flows at different locations will indicate if a leak has occurred along the piping. By necessity, several properties of the fluid must be known to correctly convert the measurement into a flow rate. Most non-compressible flow monitoring systems need critical parameters such as fluid density and viscosity. Even without these parameters, comparison of the pressures at different monitoring points can indicate the presence of a leak. Before confirming a leak, friction losses in high-volume or long piping sections may need to be calculated. Static pressure devices installed on a non-leaking pipe section should show the pressure is maintained over the duration of the test. Temperature correction may be needed if the product temperature is susceptible to change during the test; product expansion or contraction changes the static pressure.

2.2.3 Statistical Inventory Reconciliation

There are two types of SIR release detection methods: traditional and continuous. Traditional SIR takes daily manual liquid level readings of the product in the tank or uses an ATGS and reconciles product readings in the tank with the amounts of dispensed and delivered product. Continuous SIR performs the same product reconciliation as traditional; however, it can differentiate between line and tank leaks and can compensate for temperature variations with a continuous in-tank leak detection system (CITLDS). For continuous SIR, data are gathered from all designated input devices during tank quiet times when there are no sales and no deliveries.

When enough data are recorded, the SIR vendor software programs perform leak-test calculations. Most CITLDS methods use an ATGS to gather product-level data; this is considered a hybrid SIR method. Other CITLDS methods gather product-level data from input devices such as dispenser totalizers and point-of-sale records. CITLDS are well suited to facilities that are open 24 hours a day, 7 days a week, as long as the volume of the product sold from USTs does not exceed the throughput limit of the CITLDS method and there is enough quiet time to collect adequate data. For more information on test procedures for evaluating these types of release detection methods, refer to *Evaluation Protocol for Continuous In-Tank Leak Detection Systems* protocol revised on January 7, 2000 by Dr. Jairus D. Flora, Jr. More recent versions of this protocol may be used if listed as acceptable by the National Work Group on Leak Detection Evaluations (NWGLDE).

The SIR methods then use these inventory records to perform a statistical analysis of inventory discrepancies. CITLDS methods, in comparison to periodic measurements, provide a larger quantity of data, which compensate for temperature and typically provide better data for SIR analysis. Various components that might contribute to these discrepancies are generally isolated before a leak rate is estimated. Although a qualitative SIR evaluation option was previously allowed, EPA no longer allows this type SIR method. The federal UST regulation only allows quantitative methods.

2.2.4 Tank Tightness Testing

Out Of Tank Vapor And Liquid Release Detection

Vapor-phase out-of-tank product detectors are non-volumetric methods that employ instruments designed to detect hydrocarbon product vapors in the vadose zone or backfill area around an UST. The detector relies on the high volatility of some chemical components of gasoline and the ability to measure them at low concentrations. Thus, sampling the soil gas surrounding an UST or within the tank top sump for gasoline components, such as benzene or toluene, can be used to detect UST system leaks. However, you cannot quantify the fuel leak rate using this method.

A variation of this method is an external tracer. In this method, a volatile tracer compound is added to the product stored in an UST and the tank backfill around the UST is monitored for this tracer. The tracer must completely mix into the product yet be volatile enough to separate from the fuel after a release from the tank. The tracer then migrates through the tank backfill to a monitoring location where it is collected and later analyzed in a laboratory by gas chromatography - mass spectrometry.

Liquid-phase out-of-tank product detectors are non-volumetric methods that employ instruments designed to detect a free-product layer on the water table in an observation well near an UST or on water collected in a dispenser sump. Free-product detectors are commonly used in site remediation monitoring wells and rely on the immiscibility of petroleum products and water. Gasoline that leaks from an UST and intercepts the water table will rise to the top of the water column in an observation well and be detectable as a layer of product on top of the water. Although leaks can be detected using these detectors, the leak rate cannot be determined.

Acoustical methods, which are different from the ultrasonic ATGS, make use of an acoustic sensor to detect the sound of fuel leaking out of an UST or water or air leaking into a tank. By placing a tank under a slight negative pressure test condition, the airflow leak can be introduced into the tank. To use this method, interfering sounds must be eliminated and only qualitative leak determinations are possible. In addition, if the groundwater level is above the bottom of an UST, water may enter the tank without an audible sound. Therefore, these methods include a water detection component. One type is based on conductivity and referred to as a conductivity water probe. A gauge measures current flow when water ingress contacts a probe while under vacuum. In ethanol-blended gasoline, it is difficult to determine water ingress due to minimal conductivity of the transition zone between low ethanol-blend gasoline and phase separation; it will not work in high ethanol-blends due to the high conductivity of the high ethanol blend.

Interstitial Integrity Monitoring

Interstitial integrity monitoring is a method used on secondarily contained tanks and piping. Dry interstitial monitoring is performed in one of two ways: a vacuum or pressure is induced in the interstitial space and the pressure differential is monitored in the space; or a sump or reservoir is connected to the interstitial space to allow liquid leaking into the space to collect and be detected by liquid detection methods. Wet interstitial monitoring is performed with the interstice full of liquid, usually brine, with a change in liquid level indicating a release into or out of the interstice. These options can be performed continuously or intermittently; no other parameters must be monitored to make adjustments based on the observations.

Water Detection

Traditional water detection methods make use of the insolubility of water in non-ethanol blend gasoline, which is immiscible; these methods are specifically calibrated to detect the density of water. The unexplained presence of water in a tank indicates a potential leak that must be investigated.

A water float is located on the bottom of the tank where water may collect as a denser phase than the fuel. As the water or water phase, which is a water-ethanol mixture, height increases, the float rises and transmits an electronic signal proportional to the level of the denser phase in the bottom of the tank. The inventory measurement also registers an increase in volume given water ingress, although the quantified amount may not be accurate depending on the water solubility of the fuel and proportion of a bio-component in the fuel, such as ethanol. Because these methods must function in a wide range of fuel densities, a traditional water float is too dense to float on the interface layer between the aqueous phase and ethanol-blended fuel.

Aqueous phase density floats are water detection methods that are calibrated for aqueous phase detection; they are density-based methods that address concerns with ethanol-blended fuel and its ability to absorb water. When enough water is absorbed, the ethanol and water separate from the hydrocarbon phase and settle to the tank bottom. The density of this water-ethanol bottom is less than that of water alone. As a result, traditional water floats do not consistently detect this aqueous phase. These newly developed methods employ either a float with a density sensitive to

ethanol-water mixtures or a sensor to directly measure the density or conductivity of the ethanol-water mixture at the bottom of a tank.

2.3 Release Detection Method Evaluation

The evaluator follows EPA standard test procedures to evaluate release detection methods. The goal is to establish regulatory performance criteria so a similar approach is taken in the test parameters and designs, statistical analyses, and reporting. The release detection methods are usually installed on an UST system for a particular test or permanently and can be made up of many components that offer different release detection modes. All release detection modes must be evaluated and the entire system evaluated against the regulatory performance level. That means additional test procedures are included in the standard test procedures for system components, such as water ingress detection modes and sensors used in various places of an UST system. Of EPA's four main standard test procedures, the ATGS and the volumetric and non-volumetric tank tightness test methods include additional test procedures for testing these components individually. Table 3 summarizes the scope of EPA's four standard test procedures. You can use it as a guide for determining the most appropriate test procedure to use in an evaluation.

Table 3. Summary Of The Scope Of Each Standard Test Procedure

Standard Test Procedures Method Category	Scope	Performance Parameter
ATGS	• Quantitative ATGS release detection ○ Optional lowest product level tests	• P(d) of 95% with P(fa) of 5% at 0.2 gal/hr for monthly monitoring
	• In-tank water ingress detection • Change in liquid level or wet interstitial monitoring	• Minimum detectable water level • Minimum water level change
Pipeline	• Quantitative piping release detection systems • Qualitative piping release detection systems • Bulk piping release detection systems ○ > 50,000 gallons • Optional trapped vapor tests	• P(d) of 95% with P(fa) of 5% for 3 gal/hr at 10 psi for hourly testing • P(d) of 95% with P(fa) of 5% at 0.2 gal/hr for monthly monitoring • P(d) of 95% with P(fa) of 5% at 0.1 gal/hr for annual TTT • Monitoring bulk piping is dependent on the test section volume and summarized in Table 1 in the standard test procedures
SIR	• Quantitative SIR release detection ○ Single or syphoned USTs	• P(d) of 95% with P(fa) of 5% at 0.2 gal/hr for monthly monitoring

Tank Tightness Testing: Volumetric and Non-Volumetric	• Quantitative or volumetric release detection systems
	• Qualitative or non-volumetric release detection systems
	  ○ Acoustical methods
	• Tracer methods
	• Sensors
	  ○ Discriminating and non-discriminating liquid phase
	  ○ Product vapor phase
	• Vacuum decay
		• P(d) of 95% with P(fa) of 5% at 0.1 gal/hr for annual TTT
		As applicable for device capabilities:
		• Average detection time
		• Liquid activation height
		• Accuracy
		• Precision
		• Specificity
		• Average recovery time

2.3.1 Test Designs

The approach to evaluating a release detection method is specific to the release detection method category; however, the evaluator must test the methods following the same basic approach to all method categories for both quantitative and qualitative method results. When the release detection method can quantify the leak rate yielding volumetric results, fewer tests are needed to establish the needed P(d) and P(fa). The basic test design includes varying the test conditions with a minimum of 24 test results: leak rates (4 total, including a no leak condition), fill heights (2 or 3), and temperature differentials (3). You may add optional tests to this basic design to

demonstrate other method capabilities. When a method determines a leak against a threshold and gives a qualitative or non-volumetric result, the number of tests increases to at least 42. This second test design uses the same conditions but may be modified according to operating principle. For example, temperature may or may not be a factor; therefore, it may not need to be included in the test design. Depending on the performance standard, the targeted leak rates used during testing will vary. The individual standard test procedures establish which specific test design to follow based on the release detection method capabilities.

EPA's standard test procedures were written with a focus on the most common motor fuel products stored in USTs as of the time of publication. These fuels include non-alcohol blended gasoline, alcohol blended gasoline, and diesel. EPA anticipates there will be many fuels introduced to the nation's fuel supply over time. The test procedures may be used to verify release detection equipment performance in similar as well as dissimilar fuels to those listed. Several test procedures indicate this allowance in specific sections. Evaluators should at minimum, analyze the operating principle of the release detection method against target fuel properties that include, but are not limited to: coefficient of thermal expansion, concentration of or lack of petroleum, dielectric constant, electrical conductivity, and viscosity. The evaluator must provide this analysis on the appropriate reporting form to verify decisions to include other fuels as comparably performing, with or without limitations, as a tested fuel.

2.3.2 Statistical Analysis

The statistical calculations are similar across all test procedures. The performance of a release detection method is expressed in terms of the P(fa) and P(d(R)), where R is the leak rate. Generally, the volumetric release detection method – either a precision tank test or the leak test function of an ATGS – or SIR estimates a leak rate. This calculated rate is compared to a vendor-stated Th. If the calculated rate is in excess of Th, the tank is declared leaking; otherwise, the tank is called tight. For non-volumetric release detection methods, the rate is not quantified: however, the P(fa) and P(d(R)) are calculated using pass or fail results at the tested leak rates. The calculations are similar; but the number of tests in the test design is larger to evaluate non-volumetric results at the regulatory performance standard.

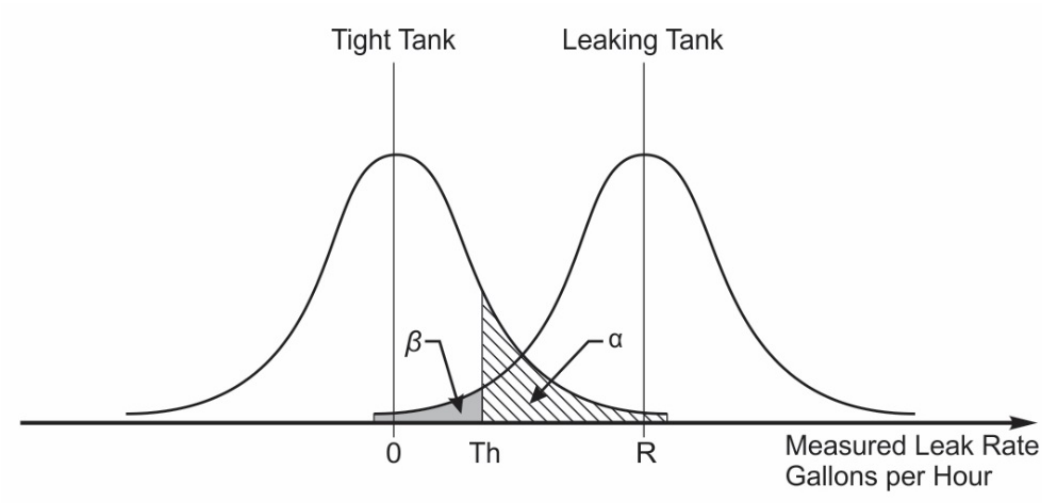
Figure 2 represents the process of determining whether a tank is leaking. The curve on the left represents the inherent variability of the measured leak rate on a tight tank with zero leak rate. If the measured leak rate exceeds Th, the tank is declared to leak, which is a false alarm. The chance of this happening is represented by the shaded area under the curve to the right of Th, denoted alpha (α).

The variability of the measured leak rates for a tank that is actually leaking at the R is represented by the curve on the right in Figure 1. Again, a leak is declared if the measured rate exceeds Th. The probability the leaking tank is correctly identified as leaking is the area under the right-hand curve to the right of Th. The probability of mistakenly declaring the leaking tank tight is denoted by beta (β), the area to the left of Th under the leaking tank curve.

Changing Th changes both α and β for a fixed R. If R is increased, the curve on the right will shift further to the right, decreasing β and increasing the P(d(R)) for a fixed Th. If the precision

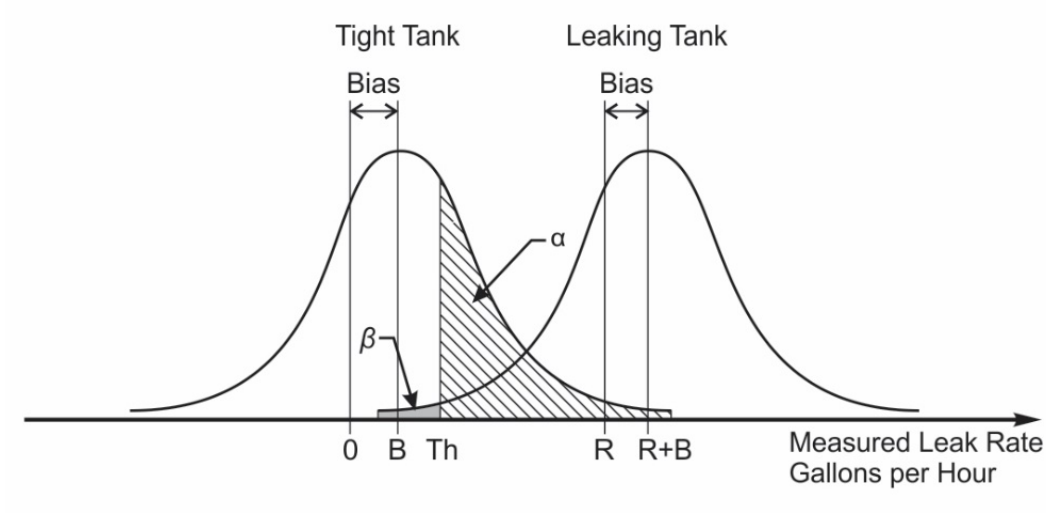
of a method is increased, the curve becomes taller and narrower, decreasing both α and β, resulting in improved performance.

A bias (B) is a consistent error in one direction; see Figure 2. In it, both curves have been shifted to the right by an amount of B. In this illustration, B indicates a greater R than is actually present; B is positive in this case. This has the effect of increasing the P(fa), while reducing the probability of failing to detect a leak. That is, the P(d(R)) of the size of R is increased, but so is the chance of a false alarm. B toward underestimating R would have the opposite effect. That is, it would decrease both the P(fa) and the P(d(R)).



Th	=	Threshold for declaring a leak; a leak is declared if the measured rate exceeds Th
α	=	Probability of false alarm, P(fa)
β	=	Probability of not detecting a leak rate, R
I – β	=	Probability of detecting a leak rate R, P(d(R))
R	=	Leak rate

Figure 1. Distribution Of Measurement Error On A Tight And Leaking Tank



Th	=	Threshold for declaring a leak; a leak is declared if the measured rate exceeds Th
α	=	Probability of false alarm, P(fa)
β	=	Probability of not detecting a leak rate, R
I – β	=	Probability of detecting a leak rate R, P(d(R))
R	=	Leak rate
B	=	Bias

Figure 2. Distribution Of Measurement Error On A Tight And Leaking Tank With A Positive Bias

2.3.3 Report Organization

The evaluator must report the results of release detection method evaluations in a similar fashion regardless of the type of method evaluated. Appendix B of each standard test procedure provides the evaluator with instructions and standard forms to collect and report the data. The test procedure for volumetric and non-volumetric tank tightness testing also has reporting forms presented in Appendix B for volumetric methods and Appendix C for non-volumetric methods.

Appendix B has several main parts. The number of parts vary depending on the specific test procedure. Each of the main parts are preceded by instructions for their completion. Appendix B includes a form for each of the main parts. Once the forms are completed and compiled, they constitute the report. Here is an example, of typical forms contained in Appendix B:

- Part 1: Results of EPA standard evaluation form. This standard evaluation form summarizes the overall findings and conclusions from the testing. UST owners and operators use this form as an executive summary to verify the performance of their chosen release detection method. The standard evaluation form is structured so the results can be easily understood and is required in the report.
- Part 2: Method description form. This release detection method description form is included in Appendix B of each test procedure. The evaluator, assisted by the vendor, should complete it.

- Part 3: Reporting form. This reporting form for leak rate data is described in Appendix B of each test procedure. The form summarizes test results and contains information about starting dates and times, test duration, and leak rate results.
- Part 4 (optional): Individual test logs. Individual test logs record raw data collected during testing; the test logs document the quality of the data used to evaluate the performance estimates of the release detection method. These test logs are not mandatory for the report and the evaluator must maintain them.

With various methods, Appendix B also includes additional forms for data collection and additional room on the reporting forms for tests conducted in addition to the basic test design. There may be a section of the report summarizing the raw data collected for demonstrating additional capabilities of the release detection method, for example water detection or trapped vapor. The individual test logs containing raw data are not mandatory for the report and must be maintained by the evaluator. The conclusions from the optional tests may be reported on the designated places within the standard evaluation form or reporting form.

2.4 Alternative Availability Of Release Detection Method Performance Verification

The federal UST regulation requires that UST owners and operators obtain and keep on file release detection method performance claims and their manner of determination described in writing by the vendor or installer (40 CFR 280.40 (a)(3)). Evaluators, such as consulting firms or test laboratories without organizational conflict of interest, typically prepare release detection reports. The reports and data are available to all interested parties, including UST owners and operators. In addition, release detection method evaluation reports are typically submitted by vendors to NWGLDE for review. If the review determines that the evaluation results are acceptable, the release detection method is added to the NWGLDE list, available at www.nwglde.org. This list provides quality reference information about the release detection methods; that information can be useful to the regulated community and regulatory authorities.

United States Environmental Protection Agency
Land And Emergency Management 5401R
EPA 510-B-19-006
May 2019
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