Alternative Test Procedures for Evaluating Leak Detection Methods: Volumetric Leak Detection Systems for Aboveground Storage Tanks Larger than 50,000 gallons

Prepared for General Use by Ken Wilcox Associates, Inc.
December 3, 2009

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Prepared by:
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DISCLAIMER

The federal EPA does not require leak detection for Aboveground Storage Tanks. The procedures described in this document have been based on those in the EPA's standard evaluation procedures for evaluating leak detection methods for underground storage tanks.[1] This protocol was developed by modifying the "Alternative Test Procedures for Evaluating Leak Detection Methods: Mass-Based and Volumetric Leak Detection Systems for Bulk Field-constructed Tanks", Ken Wilcox Associates, November 2002

Users are cautioned that although this alternative protocol may have been reviewed and accepted by some regulatory agencies, this does not mean that all agencies will necessarily find it acceptable. All regulatory agencies within the geographic area of application should be contacted prior to testing to assure that the results will be acceptable. KWA, Inc. makes no statement regarding the applicability, acceptability, or quality of results that may be obtained by other users, nor do we guarantee that any individual regulator or agency will accept the results.

This document was prepared for use by anyone who wishes to leak test large, field-constructed tanks. Users should feel free to copy or modify this protocol without restriction in any way that is acceptable to the appropriate regulatory agency.

[1] "Standard Test Procedures for Evaluating Leak Detection Methods," EPA/530 UST-90/001-7, March to October 1990. Seven different procedures were developed for different leak detection methods and released between March and October 1990.

FOREWORD

The purpose of this document is to provide the details for an evaluation procedure developed and utilized by George Thuemling. There are several reasons why it has been necessary to develop these procedures. These include the following:

1. The federal EPA does not require leak detection for Aboveground Storage Tanks and there is not therefore a procedure for evaluating leak detection equipment designed for Aboveground Storage Tanks.

2. Vendors and users of leak detection equipment for Aboveground Storage Tanks can use the results of evaluations conducted according to this protocol to determine the effectiveness of equipment.

This document was prepared principally by George Thuemling, at Varec. The changes involved adapting the existing protocol or Mass Based systems to volumetric methods.. These revisions were reviewed by Dr. Jerry Flora, Mr. Bill Trussler and Dr. Ken Wilcox peer reviewed the document and added some information t0 complete the document. and prepared the final draft.

KWA EVALUATION PROCEDURES

This project was a collaborative effort by several people with interest in above ground storage tanks. The principle force behind this effort was provided by Mr. Georg Thuemling, environmental Department Manager at Varec, Dr. Jerry Flora, Mr. Bill Trussler and Dr. Ken Wilcox provided review and comments on the protocol. The report was issued under the KWA cover. KWA, Inc. is an independent, internationally recognized third-party evaluation laboratory.

The procedures described in this document are based on operating experience, recognized scientific and engineering practices, and the guidelines provided by the EPA and ASTM. Existing procedures have been adopted when practical. Alternatives have been developed as necessary to meet the specialized requirements of leak detection systems that are not covered by the existing protocols. Questions regarding these procedures should be addressed to:

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Table of Contents

1.0 INTRODUCTION

1.1 Background

This document provides an evaluation procedure that may be used for volume-based leak detection systems designed for Aboveground Storage Tanks (ASTs). There is not an official federal protocol for testing AST leak detection equipment. The procedures described in this document have incorporated many of the procedures contained in the EPA protocols for smaller, underground storage tanks.

This testing is designed to be used with operating facilities. It does not require that a tank be taken out of service for a long period of time. Rather, it anticipates testing during intervals between major additions or removals of product from the tank. The tank will have to be stable (without additions or withdrawals of product) during the duration of each test.

1.2 Applicability

This protocol applies to volume-based leak detection equipment designed to conduct leak detection testing on vertically walled ASTs with volumes larger than 50,000 gallons. **This protocol addresses temperature variations related to product transfers and diurnal conditions, which have a direct effect on volume-based methods, by requiring at least six tests following a fill by their recommended stabilization time.** Although leak detection systems intended for use on tanks smaller than 50,000 gallons might be adequately evaluated using the procedures described in this protocol, other evaluation procedures should be considered for those systems.

This protocol does not define the performance necessary to achieve regulatory compliance. **It does provide data necessary for calculating the minimum leak rate that can be detected with a probability of 95% or greater and a probability of false alarm of 5% or less.** The issue of compliance is left to the regulatory authority having jurisdiction. Persons using this protocol should check with the appropriate agency to determine if the method is satisfactory.

Leak detection methods being evaluated shall be complete and representative of the actual equipment that will be installed or sold to the end user. Use of this protocol for testing prototype equipment with an objective of third-party certification is discouraged.

1.3 Safety

This discussion does not purport to address the safety considerations involved in evaluating leak detection equipment and methods for aboveground storage tanks. The equipment used should be tested and determined to be safe for the products it is designed for. Each leak detection system should have a safety protocol as part of its standard operating procedure, which specifies requirements for safe installation and use of the device or method. Vendors should supply their safety protocol to the personnel involved in the evaluation. All safety procedures appropriate for the product in the tanks should be followed. In addition, any safety procedures required for a particular set of test equipment should be followed.

This test procedure only addresses the issue of the system's ability to detect leaks. It does not address testing the equipment for safety hazards. The manufacturer needs to arrange for other testing for construction standards to ensure that key safety hazards such as fire, shock, intrinsic safety, and product compatibility are considered.

2.0 TANKS AND TEST EQUIPMENT

2.1 Tanks

The use of this protocol has been restricted to vertical-wall ASTs with nominal volumes of 50,000 gallons or larger. Operating tanks may be used to conduct the evaluations described in this protocol as long as they can be taken out of service for the time necessary to conduct the testing. The test tank should be known to be tight and not have a history of problems. The use of tanks with problems can seriously compromise the test results and may result in a degradation of the performance of the system under evaluation.

2.2 Fixed vs. Floating Roofs

ASTs can be constructed with fixed roofs or floating roofs. This protocol does not require that leak detection methods be evaluated on both fixed and floating roof tanks. End-users are cautioned that floating roof tanks may affect leak detection equipment if there is uneven movement of the roof along the circumference of the tank. It is expected that the roof does not stick and that the results on floating roof tanks would be similar to those of fixed roof tanks.

2.3 Test Equipment

The vendor or manufacturer will supply the equipment for each tank test method. In general, the test equipment will consist of some method of monitoring the amount of product in the tank and any changes that occur over time. Equipment typically includes instrumentation for collecting and recording the data and for using the data to calculate a leak rate.

If the test equipment is to be installed permanently and left to the tank owner to be operated, the evaluating organization personnel may operate the equipment after undergoing training from the vendor.

3.0 LEAK SIMULATION EQUIPMENT

Product is typically removed from the tank at a uniform rate using a small pump or orifice device. The volume of product removed from the tank over a specified time period is used to determine the induced leak rate. The volume of product removed during the test can be determined volumetrically or gravimetrically with conversion to volume using the fuel density.

Suitable devices for leak simulations include peristaltic pumps, calibrated flow meters or any device that can maintain a steady flow of liquid over a sustained time period of several days.

4.0 PRODUCT

Any hydrocarbon product of grade number 2 or lighter may be used. Acceptable products include gasoline, number 2 diesel fuel, aviation fuel, Jet-A, JP-4, JP-5, JP-8, and kerosene. Other products may also be acceptable but some limitations could result from a poor choice of liquids used during the evaluation. Highly viscous materials such as motor oil should not be used unless the leak detector is designed to test viscous products.

The vendor must specify on the results forms (included in Appendix A) how the procedures account for or compensate for the variations in volatility of different fuels types because product volatility may affect the test method and the associated test results.

5.0 EVALUATION PROCEDURES

5.1 Evaluation Summary

A summary of the evaluation is as follows:

1. The vendor installs the leak detection equipment in the evaluation tank.
2. The third-party evaluator installs leak simulation equipment in the evaluation tank.
3. Leaks are induced into the tank by the third-party evaluator, blind to the vendor.
4. The leak detection equipment is programmed to initiate a leak detection test.
5. The third-party evaluator maintains leak conditions for the duration of the testing.
6. Results of the leak tests are collected by the third-party evaluator from the leak detection equipment or the leak detection vendor.
7. Steps 2 through 6 are repeated until a minimum of 24 tests have been completed. (At least 6 tests must be done after the tank has been in use and then refilled.
8. The reported results are compared to the induced leak rates and a report detailing the results of the analysis is prepared.

5.2 Induced Leak Rates

A minimum of 24 tests should be conducted. A minimum of 6 tests must be conducted with actual induced leaks present. If 24 tests are conducted, up to 18 of the 24 tests may be conducted without an induced leak (zero leak tests). The actual induced leak rates and the vendor's reported leak rates will need to be recorded for each leak detection test. The threshold for the method to produce a P_{FA} of 5% or less and a P_D of 95% or greater will be determined from the test results.

In general, the leak rates induced during the testing are those indicated in Table 1. The rates in Table 1 are based upon the target leak rate set by the equipment vendor, based upon their expectations of performance. The rates are not be used as a guideline, however, and variations in leak rates from Table 1 should not affect the results of the evaluation. The important parameter that is determined during the evaluation is the difference between the rate reported by the vendor and the actual induced leak rate.

Table 1. Example Induced Leak Rates for Two Target Leak Rates

		Example Target Leak Rates		Suggested Number of Tests
Leak No.	Rate (gal/hr)	1.0 gal/hr	2.0 gal/hr	
1	Zero leak rate	0.0 gal/hr	0.0 gal/hr	Maximum of 18
2	½ x target leak rate	0.5 gal/hr	1.0 gal/hr	Minimum of 2
3	1 x target leak rate	1.0 gal/hr	2.0 gal/hr	Minimum of 2
4	2 x target leak rate	2.0 gal/hr	4.0 gal/hr	Minimum of 2

5.3 Zero Leak Rates versus Induced Leak Rates

The evaluation allows for the majority of tests to be zero leak tests, assuming that blind test conditions can be maintained. A majority of zero leak tests are allowed for several reasons. Zero leak tests can be conducted without personnel present, which will make an evaluation more economically feasible. Leak simulation equipment will not be required for zero leak tests, which is one of the main requirements for having personnel present. Since testing large ASTs will likely require 24 hours or more per test, the economic costs of conducting an evaluation during which personnel must be present for all 24 tests would be prohibitive. In many cases, personnel do not have to be present to start and stop tests or to record results. Most current systems include some form of communication that allows for electronic downloading of test results and for tests to be started and stopped remotely.

If more zero leak tests are conducted without personnel present, it may be possible to schedule several leak tests immediately following tank fills that occur as a part of normal fueling operations. The logistics and costs involved with moving large volumes of fuel in and out of these tanks makes simulating tank fills very difficult for an evaluation. **This protocol recommends that at least 6 of the 24 tests be conducted immediately after a tank fill to demonstrate that the leak detection method is capable of conducting testing without adverse effects following tank fills.**

From a statistical point, it does not matter if a leak is present or not to determine the P_D and the P_{FA} of a leak detection method. The difference between the actual induced leak rate and the reported leak rate is the important parameter in determining the P_D and the P_{FA} of a leak detection method. Assuming the induced leak rates are measured correctly, this difference should be independent of the rate of the leak and therefore, the number of induced leak tests versus the number of zero leak tests is less important. The calculations do include a requirement for performing an F-Test comparison to determine if there is a statistical difference between the leak tests and the zero leak tests. If the F-Test comparison fails, the evaluator will review the test data for accuracy and the larger standard deviation of the leak and non-leak tests will be used to calculate P_D and P_{FA} of a leak detection method.

5.4 Minimum Testing Time

Each test method requires a minimum test time to obtain its performance accuracy. . The minimum test time requirement shall be used during the evaluation. The minimum test time will become part of the vendor’s standard test procedure and will be used for all subsequent field testing using that method. The test times used in the evaluation will be recorded and the average test time reported as the minimum test time required by the method. Any reasons for the unusual test durations should be documented. Leak tests must be conducted for at least the average test time, irrespective of tank size. Scaling down test times is not permitted.

5.5 Tank Fills

Six tank fills are recommended for this evaluation to demonstrate that the leak detection method is capable of conducting testing without adverse affects following tank fills. The tank fill may be done prior to the start of the evaluation or during some other point of the evaluation. Due to the economic and operational difficulties associated with filling very large tanks, this protocol does not specify the amount of the product transferred and the timing of the transfer. The evaluator and the vendor should work with the tank operator in scheduling the tank fill.

This protocol has been written for volume-based systems, which are affected by product temperature changes that are the result of product deliveries and environmental effects.

It is expected that most leak detection equipment evaluated using this protocol will be designed for ASTs that are larger than 50,000 gallons, up to millions of gallons.   As mentioned above, tank fills should be scheduled as a part of normal fueling operations.

6.0 ENVIRONMENTAL DATA RECORDS

The following environmental data should be recorded. Weather station data may be used if available.

- Ambient temperatures during the testing
- Barometric pressure during the testing
- Special weather conditions occurring during the testing that might alter the test results, such as rain, high winds, storm fronts, cloudy or sunny conditions, etc.
- Any other condition that might influence the test results

The above information should be recorded for each test on the individual test logs included in Appendix B. **The test log forms are provided as a convenience for recording the data. They are not required as part of the final report**.

7.0 CALCULATIONS

All of the standard calculations described in the standard EPA test protocol for volumetric systems apply to evaluations conducted on ASTs. The threshold and MDL to obtain a probability of detection (P_D) of 95% and probability of false alarm (P_{FA}) of 5% are to be reported for the evaluation. Procedures for determining the P_D, P_{FA}, and MDL are contained in the standard EPA test protocol for volumetric systems and are summarized below.

7.1 Basic Statistics

For the differences between the leak rates reported by the system, L_i, and the induced leak rates, IL_i,

$$D_i = L_i - IL_i. \quad (7\text{-}1)$$

The bias is estimated by the mean of the differences:

$$B = \sum D_i / N, \quad (7\text{-}2)$$

Where N is the number of tests in the evaluation and the summation is over all differences. The variance of the differences is found using the formula

$$V = \sum (D_i - B)^2 / (N - 1). \quad (7\text{-}3)$$

The standard deviation, S, is the square root of the variance. A test of whether the bias is zero is based on the statistic

$$t = (N)^{1/2} B / S, \quad (7\text{-}4)$$

which is compared to the two-sided value from a t-distribution with N-1 degrees of freedom for a level of significance of 5%. For N = 24, the appropriate value from the t-table is 2.069. If the absolute value of t is less than the value from the t-table, then B is negligible. This means that zero is substituted for B in the following equations.

7.2 F-Test Comparison of Zero Leak Tests versus Induced Leak Tests

A two-sample F test should be done to compare the zero leak tests with the induced leak tests. To make this comparison, divide the data records into two groups. One group should include the zero leak tests and the other group should contain the induced leak tests. Calculate the mean and standard deviation separately for the two groups. Use a two-sample F test to test whether the variances of the two groups are equal. Calculate

$$F = (S_1 / S_2)^2 \quad (7\text{-}5)$$

where S_1 and S_2 are the standard deviations calculated from the two groups. In forming the F ratio, use the standard deviation with the larger calculated value in the numerator. Compare the calculated value of F to the 95th percentile of an F-distribution with ($n_1 - 1$) degrees of freedom in the numerator (corresponding to S_1) and ($n_2 - 1$) degrees of freedom in the denominator (corresponding to S_2). The sample sizes are n_1 and n_2, respectively.

If the calculated value of F is less than the tabled value, there is no significant evidence that the two population variances are different. If the calculated value of F exceeds the tabled value, the two variances are significantly different at the 5% significance level.

If the F-test shows that the results of the zero leak tests and the induced leak tests are not significantly different from each other, the standard deviation of the combined data sets should be used to calculate P_D and the P_{FA}. If the F-test shows that the results are significantly different, the larger standard deviation of the two groups should be used to calculate the P_D and the P_{FA}. The evaluator will also review the test data for accuracy.

7.3 Probability of False Alarm (P_{FA}), Probability of Detection (P_D), Threshold, and Minimum Detectable Leak (MDL)

Probability of False Alarm

The probability of false alarm P_{FA}, is the probability that the measured leak rate will exceed the threshold for declaring a leak when the testing is done on a tight tank. If the threshold is denoted by C, then the probability of a false alarm is estimated from

$$P_{FA} = P\,[t > (C - B) / S] \qquad (7\text{-}6)$$

This probability is calculated by computing the term (C – B) / S using the specified threshold C and the bias, B, and standard deviation, S, computed from the test results. The result is used with a t-distribution with 23 degrees of freedom (assuming 24 tests were conducted). A table of the t-distribution is used to find the probability that a t-statistic with 23 degrees of freedom exceeds the computed value.

Probability of Detection

The probability of detecting a leak depends upon the specified leak rate. For a leak rate of size R, the probability of detection, P_D, is given by

$$P_D = P\,[t > (C - R - B) / S]. \qquad (7\text{-}7)$$

In the formula, the threshold, C, is specified as before, the leak rate for which the PD is calculated is R, and B and S are calculated form the test data as before. The term (C-R-B)/S is computed. A t-distribution with 23 degrees of freedom is sued to look up the probability that a t-statistic exceeds the calculated value.

Setting the Threshold

The threshold, C, may be set to give a specified probability of false alarm. For example, if a P_{FA} of 5% is desired, use the t-table to determine that the probability is 5% that a t-statistic with 23 degrees of freedom will exceed 1.714. To choose C, set

$$(C - B) / S = 1.714 \qquad (7\text{-}8)$$

and solve for C to get

$$C = (1.714)(S) + B \qquad (7\text{-}9)$$

which reduces to

$$C = (1.714)(S) \qquad (7\text{-}10)$$

if B is zero.

Here B and S have been calculated from the test data, but B is taken to be zero if it is not statistically different from zero at the 5% level.

Finding the Minimum Detectable Leak Rate

For a specified threshold C, the smallest leak rate that can be detected with a specified probability, e.g. 95%, can be determined as the minimum detectable leak rate, MDL. This is accomplished by using a t-table to find the probability that a t-statistic with 23 degrees of freedom will exceed -1.714. Set

$$(C - R - B) / S = -1.714 \qquad (7\text{-}11)$$

The value of R that solves the above equation is the MDL for the threshold C.

$$MDL = C - B + 1.714\,(S) \qquad (7\text{-}12)$$

The value of R that satisfies the previous equation using the threshold for a 5% P_{FA} is the MDL for a 5% P_{FA} and a 95% P_D. This is the smallest leak rate that is detectable with 95% probability using the threshold C. Note if the bias is not statistically significantly different from zero it is taken to be zero.

7.4 Tank Size Limitations

Differing tank sizes and geometries can affect the quality of testing. The parameters that affect the relationship between the noise in a test and the tank size are not always well understood and may be a function of the specific type of technology that is under evaluation. Possible sources of variability include tank volume and surface area. It is probable that both are always present. For this protocol, tank size limitations have been based upon surface area because the methods being evaluated are volume based. The results of an evaluation may be applied to tanks smaller than the test tank down to a volume of 50,000 gallons. The evaluation results may be used on tanks with a product surface area up to 2.5 times larger than the test tank.(with the appropriate scaling) Table 2 summarizes applying the evaluation results to tanks of differing sizes.

Table 2. Tank Size Limitations

	Product Surface Area	Product Volume
Scaling Limits	Maximum 2.5 x surface area, no minimum	50,000 gallon minimum, no maximum

7.5 Target Leak Rate and Threshold

Once the data are available and the statistics have been calculated the following results are to be reported on the official results forms.

- Standard deviation
- Threshold for declaring a leak
- Minimum detectable leak rate
- Target leak rate
- P_{FA} and P_D for the target leak rate

The evaluator and the vendor may select any target leak rate and threshold consistent with the test data. The minimum value for the threshold to achieve a P_{FA} of 5% is 1.714 times the standard deviation, S. This choice would give the smallest minimum detectable leak rate (of twice the threshold, assuming that the bias is not significant). Target leak rates and thresholds should also meet the specifications of the regulatory agencies located in areas that the leak detection method is expected to operate in. In general, the results must show that the system is capable of detecting the target leak rate with a probability of detection of 95% or greater and a probability of false alarm of 5% or less. The threshold can be adjusted within these limits to either reduce the probability of false alarm or improve the probability of detection.

The threshold can also be adjusted to reduce the target leak rate by setting the P_D to its minimum, 95% or setting the P_{FA} to its maximum, 5%.

The vendor may choose to report the test results using more than one target leak rate and threshold. A different version number should be used for the results with different target leak rates. A separate results form must be prepared for each different target leak rate.

7.6 Leak Rate and Threshold Scaling

A simple approach to developing scaling performance of volume measurement systems to other tank sizes has been taken. The relative surface area of two tanks is considered to be the largest contributor to performance variability between tank sizes. The standard deviation of the reference tank is multiplied by the ratio of the surface areas of the size of tank to which the evaluation results are to be applied. This can be expressed mathematically by the equation

$$S_2 = S_1 \times A_2 / A_1 \qquad (7\text{-}13)$$

Where S_1 is the population standard deviation obtained from the evaluation test data using a reference tank, S_2 is the population standard deviation to be used to predict performance on a tank of a different size, A_1 is the surface area of the evaluation reference tank, and A_2 is the surface area of the new tank.

The scaling is limited by the following restrictions.

1. The tank must have vertical walls
2. Leak rate scaling is based on the product surface area

The maximum size tank that may be tested is determined by consideration of the performance of the method as measured by the standard deviation. The standard deviation is scaled up using equation 1. A new minimum leak rate for a P_D of 95% must then be calculated for the larger tank. For example, to apply a test method that has been evaluated on a tank with a surface area of 2,000 square feet with a measured standard deviation of 0.5 gal/hr to a tank with a surface area of 3,000 square feet, a new minimum detectable leak based upon a standard deviation of 0.75 gal/hr would be used.

The maximum tank size to which the method may be applied is limited to not more than 2.5 times the surface area of the tank used for evaluation. Scaling to smaller tanks is allowed.

When scaling the results, the standard deviation of the results obtained during the evaluation should be used for S1 in equation (7-13). This is the standard deviation calculated from the test data using equation (7.3) if the results are based on a single test.

The results form contains a table that lists the performance parameters for the test tank and for the maximum size tank for scaling. Additional tables representing results for other sizes of tanks may be included by the evaluator if the vendor so desires.

7.7 Minimum Test Time

The test time is measured from the start of data collection to the end of the data collection. Some systems will report a leak at this time, but others may require additional data processing off site. Test times for all tests should be included in the average. Leak tests must be conducted for at least the average test time, irrespective of tank size. Scaling down of test times is not permitted.

7.8 Testing Following Tank fills (Product Deliveries)

The results form contains a space for the vendor to state any procedures used to determine when a tank is stable following tank fills. Any minimum required stabilization times following tank fills and any effects of testing following tank fills with temperature differentials are specified by the vendor. At least six tank fills will be done during the evaluation to verify that the test method is not adversely affected by the deliveries.

7.9 Fuel Volatility

Any procedures used to account for fuel volatility must also be stated on the results form. The evaluator must agree that these approaches are reasonable for the method under evaluation.

8.0 REPORTING OF RESULTS

8.1 Certification Forms

Appendix A contains the certification forms, which are designed to be the framework for a standard report. There are three parts to Appendix A, each of which is described below.

Results Form

The "Results of Alternative Test Procedures" form is basically an executive summary of the findings. It is designed for use as a form that would be provided to each tank owner/operator that uses this method of leak detection. If the vendor chooses to report more than one set of performance criteria, the table attached to the results section must be completed for each set. The report should be structured so that this Results form can be easily reproduced for wide distribution.

Description Forms

The "Description of the Aboveground Storage Tank Leak Detection Method" form contains details about the technology and operation of the leak detection method. This form should be completed by the evaluating organization assisted by the vendor.

Reporting Forms

The "Reporting Form for Leak Rate Data" summarizes the individual test results and contains information on starting dates and times, test duration, leak rate results, etc.

8.2 Individual Test Logs

Appendix B contains the individual test log sheets, which are provided as a convenience for the evaluator. The individual test logs should be reproduced and used to record data in the field. Copies of the completed daily test logs are not included in the standard report. They serve as the backup data to document the performance estimates reported.

APPENDIX A

REPORTING FORMS

Appendix A contains the following:

1. Results of U.S. EPA Alternative Test Procedures: Aboveground Storage Tank Volumetric Leak Detection Method - 4 pages

2. Description Aboveground Storage Tank Volumetric Leak Detection Method - 5 pages

3. Reporting Form for Testing Conditions and Leak Rate Data – Volumetric Leak Detection Systems for Aboveground S

Results of U.S. EPA Alternative Test Procedures
Aboveground Storage Tank
Volumetric Leak Detection Method

This form describes the performance of the leak detection method described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to a modification of the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Volumetric Tightness Testing Methods." The full evaluation report also includes a form describing the method and a form summarizing the test data.

Tank owners using this leak detection system should keep this form on file to provide compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

Leak Detection Method Description

Name ____

Version number ____

Vendor ____

____
(street address)

____
(city) (state) (zip) (phone)

Evaluation Results

This Leak Detection Method which declares tank to be leaking when the measured leak rate exceeds the threshold of _____ gallons per hour, has a probability of false alarm [P_{FA}] of ____% for tests conducted on tanks with surface areas of _____________ sq ft or less.

The corresponding probability of detection [P_D] of a __ gallon per hour leak is ____%.

The standard deviation of the test data results was_________ gal/h.

The smallest leak that can be detected with a probability of detection of 95% and a probability of false alarm of 5% (MDL) is ______ gal/h in a tank with a surface area of ____ sq. feet.

The evaluation testing was conducted in a ________ gallon tank with a surface area of __ _______ sq. ft.

The tank geometry included vertical walls and was ( )_____ feet deep and _____ feet in diameter or ( ) _____ feet long, _____ feet wide and _____ feet deep.

The tank was constructed of ( ) steel ( ) fiberglass ( ) concrete ( ) other (describe)

Evaluation Results Continued

The tests were conducted with the tank product level of over ______ % full.

The product used in the evaluation was _______.

The system was operated as an automatic device. ( ) Yes ( ) No

Limitations on the Results

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for installing and operating the Leak Detection Method are followed.
- The tank contains a product identified on the method description form.
- The tank is a field-constructed tank with vertical walls of constant cross section.
- The total data collection time for the test is at least ________ hours _____ minutes.
- The maximum product surface area is no greater than _____square feet.
- The minimum tank size is 50,000 gallons.
- The threshold for declaring a leak is adjusted for different tank sizes by multiplying the ratio of the product surface area used in the evaluation, which was _______ square feet, and the product surface area in the tank being tested. The detectable leak rate is scaled up or down by multiplying in the same way.
- The detectable leak rate ( ) may ( ) may not be scaled below 0.2 gal/h.
- Other limitations specified by the vendor of determined during testing:

____
____

Procedural Information

State the procedures used to determine when the tank is stable.

____
____

State the procedures used to account for fuels of different volatility.

____
____

Other Information

Summary of Test Procedure Modifications

____

____

Other Modifications: (describe briefly)

____

____

	Test Tank Size	Maximum Size Tank	Minimum Size Tank
Diameter			
Surface Area			
Standard Deviation*			
Target Leak Rate, TLR			
Vendor's Threshold			
PFA			
PD(for target leak rate)			
MDL			

Note: Additional copies of this table for other tank sizes may be included as desired.

> **Safety disclaimer: This test procedure only addresses the issue of the Leak Detection Method's ability to detect leaks. It does not test the equipment for safety hazards.**

Certification of Results

I certify that the Leak Detection Method was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation.

________________________________ ________________________________

(printed name) (organization performing evaluation)

________________________________ ________________________________

(signature) (city, state, zip)

________________________________ ________________________________

(date) (phone number)

Date of Certification: ____

Description
Aboveground Storage Tank
Volumetric Leak Detection Method

This section describes briefly the important aspects of the aboveground storage tank leak detection method. It is not intended to provide a thorough description of the principles behind the system or how the equipment works.

Method Name and Version

____

Product

> Product type

For what products can this Method be used? (check all applicable)

- ( ) gasoline
- ( ) diesel
- ( ) aviation fuel
- ( ) fuel oil #4
- ( ) solvents
- ( ) other (list) ____

> Product level

What product level is required to conduct a test?

- ( ) greater than 90% full
- ( ) greater than 50% full
- ( ) other (specify) ____

Date of Certification: ____

Principle of Operation

What technique is used to detect leaks in the tank system?

( ) directly measure the volume of product change

( ) changes in head pressure

( ) changes in buoyancy of a probe

( ) mechanical level measure (e.g., ruler, dipstick)

( ) changes in capacitance

( ) ultrasonic

( ) change in level of float (specify principle, e.g., capacitance, magnetostrictive, load cell, etc.) ____

( ) other (describe briefly) ____________________________________

Temperature Measurement

How many temperature sensors are used to measure the product temperature?

( ) Product temperature not measured

( ) One sensor

( ) Two sensors

( ) Three sensors

( ) Four sensors

( ) Five sensors

( ) Other (describe briefly) ____

What type of temperature sensor is used?

( ) Product temperature not measured

( ) resistance temperature detector (RTD)

( ) bimetallic strip

( ) quartz crystal

( ) thermistor

( ) other (describe briefly) ____

Date of Certification: ____

If product temperature is not measured during a test, why not?

( ) the factor measured for change in level/volume is independent of temperature (e.g., mass)

( ) the factor measured for change in level/volume self-compensates for changes in temperature

( ) other (explain briefly)____

____

Data Acquisition

How are the test data acquired and recorded?

( ) manually

( ) by strip chart

( ) by computer

Procedure information

> Waiting times

What is the required waiting period between adding a large volume of product (i.e., a delivery) and the beginning of a test (e.g., filling from 50% to 90-95% capacity)?

_____Hours ____ Minutes

Additional Comments: ____

> Test duration

What is the required time for collecting data?

____ Hours ____ Minutes

Additional Comments: ____

What is the sampling frequency for the level and temperature measurements?

( ) more than once per second

( ) at least once per minute

( ) every 1-15 minutes

( ) every 16-30 minutes

( ) every 31-60 minutes

( ) less than once per hour

( ) variable (explain) ____

Date of Certification: ____

> Interpreting test results

How are level changes converted to volume changes (i.e., how is height-to-volume conversion factor determined)?

( ) actual level changes observed when known volume is added or removed (e.g., liquid metal bar)

( ) theoretical ratio calculated from tank geometry

( ) interpolation from tank manufacturer's chart

( ) other (describe briefly)

( ) not applicable; volume measured directly

How is the coefficient of thermal expansion (Ce) of the product determined?

( ) actual sample taken for each test and Ce determined from specific gravity

( ) value supplied by vendor of product

( ) average value for type of product

( ) other (describe briefly) ____

How is the leak rate (gallon per hour) calculated?

( ) average of subsets of all data collected

( ) difference between first and last data collected

( ) from data from last ____ hours of test period

( ) from data determined to be valid by statistical analysis

( ) other (describe) ____

What threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

( ) 0.05 gal/hr ( ) 0.1 gal/hr ( ) 0.2 gal/hr

( ) 0.5 gal/hr ( ) 1.0 gal/hr ( ) 2.0 gal/hr

( ) Other _____________

Additional Comments: ____

Under what conditions are test results considered inconclusive?

( ) too much variability in the data (standard deviation beyond a given value)

( ) unexplained product volume increase

( ) other (describe briefly) ____

Date of Certification: ____

Exceptions

Are there any conditions under which a test should not be conducted?

( ) extremely high or low ambient temperature

( ) invalid for some products (specify) ______________________________

( ) other (describe briefly) ____

What are acceptable deviations from the standard testing protocol?

( ) lengthen the duration of test

( ) other (describe briefly) ____

( ) none

What elements of the test procedure are determined by personnel on-site?

( ) product level when test is conducted

( ) when to conduct test

( ) waiting period between filling tank and beginning test

( ) length of test (LRDP-24 requires a minimum test time of 24 hours.)

( ) determination of "outlier" data that may be discarded

( ) other (describe briefly) ____

( ) none

Reporting Form for Testing Conditions and Leak Rate Data
Volumetric Leak Detection Systems for Aboveground Storage Tanks

Name and Version: ____

Tank Evaluation Period: from ____________ to __________ (Dates)

Test No.	Date Test Began (m/d/y)	Time Test Began (m/d/y)	Date Test Ended (m/d/y)	Time Test Ended (m/d/y)	Test Time (hours)	Product Level (%)	Nominal Leak Rate (gal/h)	Induced Leak Rate (gal/h)	Measured Leak Rate (gal/h)	Meas.-Ind. Leak Rate (gal/h)
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										
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23										
24										

APPENDIX B

INDIVIDUAL TEST LOGS

Individual Test Log
Aboveground Storage Tank Leak Detection Systems

Instructions:
Use one log for each test. Fill in the blanks and check the boxes, as appropriate. Keep test log even if test is inconclusive.

1.0 General Background Information

Product Type ____

Type of Tank ____

Tank Dimensions (nominal)

Diameter __________ inches Length/width ______/______ inches Volume _______ gallons

Ground-water level ________ inches above tank bottom (if known)

If applicable, recommended stabilization period before test (per vendor SOP)

______ Hours . Minutes

2.0 Leak Detection Test Times

Start of test data collection ____________ Date ____________________ military time

End of test data collection _______________ Date ____________________ military time

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3.0 Weather Information

	Temperature (deg F)	Barometric Pressure (mm or in Hg)	Wind Conditions (none, light, moderate, or heavy)	Precipitation (none, light, moderate, or heavy)	Sky Conditions (sunny, partly cloudy, cloudy, night)
Start of Test					
End of Test					

4.0 Leak Rate Data

Nominal Leak Rate (gal/h)	
Induced Leak Rate (gal/h)	
Vendor’s Reported Leak Rate (gal/h)	
Difference (Reported minus Induced)	

7.0 ATGS Controller Printout

Attach a copy of the ATGS controller printout with the vendor’s reported leak rate to this form (Attach additional pages if needed).

Additional Comments (Attach additional pages if needed)