Test Procedure for the Evaluation of Double Wall Pipe With Liquid Filled Interstice for Loss Prevention

PREPARED By:

Ken Wilcox Associates, Inc.

May 21, 2004

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DISCLAIMER

Some of the procedures described in this document are different than those in EPA's Standard Evaluation Protocols. Users are cautioned that, although this alternative protocol may have been reviewed and accepted by some regulatory agencies, it 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.

Preface

This alternative evaluation protocol was developed by Ken Wilcox Associates for the purpose of evaluating leak monitoring methods for double wall pipelines using liquid filled interstitial systems. This has been necessary because there is no officially recognized protocol for these types of systems. The method was submitted to a peer review committee for approval and to various regulatory agencies and groups. Users are cautioned to determine if equipment tested using this protocol is acceptable by their agency. Comments regarding this document should be submitted to Ken Wilcox Associates, Inc. by e-mail or fax to 816-443-2495.

The protocol has been reviewed and accepted by the National Workgroup for Leak Detection Evaluations.

Ken Wilcox, President
Ken Wilcox Associates, Inc.

May 21, 2004

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1.0 INTRODUCTION

This document describes the testing that can be conducted on liquid filled interstitial monitors. This makes it possible for users, regulators and other interested parties to evaluate the performance of the leak detector and to compare its performance with other similar methods. The results of this evaluation may be applied to any system that monitors the liquid level in a reservoir attached to the annular space of double wall pipe. The results forms for this evaluation can be found in Appendix A of this protocol.

While the USEPA regulations make mention of interstitial monitoring as an acceptable leak detection method, there is no officially recognized protocol for evaluating the effectiveness of liquid or liquid filled interstitial monitors for pipelines. This protocol describes testing that can be conducted to verity the performance of such systems.

Since interstitial monitoring systems are expected to be highly dependent on the type of piping materials used, this protocol addresses two sets of issues. First, the characteristics of the pipeline are determined. Second, the characteristics of the leak detection system as it is installed in the pipeline are considered.

One potential concern for these systems is in making sure that the liquid reservoir is properly sized so that normal activities at the site do not cause the level to fluctuate beyond the limit switches that are usually used to monitor for a leak. The two possibilities are that the level will drop too far, triggering a leak alarm or the level will rise too high (possibly running over) triggering a high level alarm. This protocol addresses this issue and determines if the probability of a false alarm is a problem.

Several problems can contribute to a false alarm, triggered when the liquid level drops below the lower sensor or rises above the upper sensor. These include thermal effects, particularly if air is trapped in the interstice and expansion of the primary pipe if the pipeline is constructed of flexible materials. The expansion and contraction of liquid due to temperature are expected to be much less than for fuel and will not normally be a problem for the temperature changes expected to occur in pipelines at service stations.

Because the number of tests proposed for this protocol is limited, the worst-case conditions are used when calculating the pressure and temperature effects on the liquid level.

2.0 APPLICABILITY

This procedure can be used to test any doubly contained pipeline system with a liquid filled interstice having a reservoir equipped with a dual point sensor that will alarm on both high and low liquid levels. The sensors must be connected to a control panel of some type that can be configured to provide the operator with an alarm or will shut down the dispensing if a leak occurs. This protocol does not evaluate sensor functionality. It is important to use a sensor that has been evaluated and approved for use in hydrostatic monitoring applications.

This method may be applied to interstitial systems where the interstice is pressurized as well as systems operating under ambient pressure conditions.

3.0 TEST APPARATUS

Construction of Test Line

To conduct these tests, a pipeline of the maximum length to which the evaluation can be applied must be constructed. The test pipe must have a minimum of three fittings for each 20 feet of pipe. The various fittings must include all of the types of fittings normally found in a service station and may be clustered together. Access to the ends of the test pipe must be provided for inducing leaks, circulation of fluid through the primary pipe, or other activities associated with the testing. The testing may be conducted in a laboratory or shop environment.

There must be some provision for creating a highpoint in the pipe so that a trapped air pocket can be introduced and maintained in the annular space during the testing. The air pocket must be in the lateral part of the pipe that contains the primary pipe so that it is exposed to the full effects of temperature changes during the testing. The pipeline must also be sloped toward the reservoir at a rate of ½ inch per 20 feet of line over the entire length

The liquid in the inner pipe can be water for all of the tests described here. The liquid in the interstice must be of the same type utilized by the manufacturer for installed systems. The interstice must be filled using the same procedures as specified by the pipe manufacturer at a field installation. This could include gravity feed, evacuation of the interstice prior to filling or other technique designed to minimize the amount of air trapped in the interstice. The laboratory line must be insulated from the environment so that temperature of the system is not subject to rapid temperature fluctuations produced by the ambient conditions. Aluminized Mylar bubble pack or other easy to handle material may be used.

Test Equipment

<u>Heating and cooling</u>

Provisions must be made for circulating hot and cold water through the primary pipe during the evaluation process. This can be accomplished using the equipment described below or by another equivalent method that can maintain the circulation of water at a constant temperature for at least two hours or until the entire test assembly has reached thermal equilibrium.

An insulated 55-gallon drum or other suitable container can be used as a reservoir. The water temperature can be lowered to a nominal temperature of 32 deg F by adding crushed ice to the reservoir. If an excess of ice is present, the temperature will be maintained at near 32 deg. A small, low-pressure pump can be used to circulate the water through the primary pipe. The capacity of the pump must be sufficient to provide a water flow rate between 5 and 10 gallons per minute.

Heating can be accomplished by using a small flow through heater in the water return line. The heater must be capable of heating the water to at least 110 deg F and maintaining the temperature at 100 deg F during the circulation.

Pressurizing the pipeline

To provide for the pressure testing, a pump capable of delivering a pressure up to the manufacturers pressure limit but not more than 100 psi must be used. The pump may be connected to the primary line at either the inlet or outlet of the test assembly.

Induced leaks

Leaks are created using a small peristaltic pump or other equivalent means of withdrawing liquid from the interstice. This pump must be capable of producing a constant leak beginning at start of the leak and ending when the alarm occurs. The pump should be reversible so that both in leaks and out leaks can be produced.

Monitoring the reservoir level

To determine the effects of different variables on the liquid level in the reservoir, an independent means of measuring the liquid level must be used. The use of a quality ruler is sufficient as long as the interstitial liquid can be easily read to the nearest 1/32 inch. A more sophisticated electronic level gauge such as a short magnetostrictive probe can also be used.

Introduction of air into interstice

The amount of air present in the line is estimated using the procedures described in Section 4. This amount of air will be present during all of the testing since it is a result of the pipeline design and the filling techniques. An additional amount of air equal to the existing quantity of air can be injected into the pipeline using a syringe or other equivalent method. This process doubles the amount of air that would normally be trapped if proper filling procedures are used. The trapped air tests described in Section 4 are then conducted with the added air. This test should be conducted last since the additional air cannot be easily removed from the pipeline.

Temperature measurements

Temperature measurements should be made to 0.5 deg F using a temperature device with an accuracy of 0.5 deg F. The accuracy is less important than the resolution, but all temperature devices should be calibrated to within 0.5 deg of each other. Temperature measurements should be taken in the circulation reservoir and on the outside of the interstice under the insulation within 12 inches of the inlet to the primary pipe.

Pressure measurements

Pressure measurements should be made to 1.0 psig or better. The pressure gauge should have range of twice the expected pressure range of the testing and have an accuracy of at least 3% of full scale.

Measurement of the Interstitial Volume

The volume of the interstice can be estimated by measuring the amount of liquid required to fill the interstice and the reservoir. The volume in the reservoir should be subtracted from the total volume of liquid added to obtain the interstitial volume.

4.0 DESCRIPTION OF EVALUATION PROCEDURES

The test procedures used for this evaluation are described in this section.

4.1 Pipeline Characteristic Tests

Several types of tests must be conducted to establish the characteristic of the pipeline under consideration. These include:

- Volume of fluid in the interstice
- Effects of pressure in the primary pipe on the liquid level
- Effects of temperature on the liquid level
- Effects of trapped vapor in the interstitial space
- Effects of a catastrophic failure of the primary pipe
- Flow through the interstice

These tests are conducted by monitoring the reservoir level with a device capable of measuring the actual level changes produced in the testing. The dual point sensors used for monitoring cannot be used for these tests. The test procedures are summarized below.

<u>Determination of Interstitial Volume</u>

The volume of fluid in the interstice of the test line is determined by measuring the volume of fluid that is used to fill the interstice after the line has been constructed.

1. Measure the volume of liquid in the supply reservoir before the system is filled.
2. Fill the interstice using the method prescribed by the pipeline manufacturer.
3. Measure the volume of liquid left in the reservoir after filling is complete.
4. The difference in volume is recorded as the volume of the interstice.
5. Subtract the volume of liquid in the monitoring reservoir after the filling is complete to determine the actual volume of liquid in the interstice.

It must be noted that the measured volume does not include the volume of any trapped air or vapor in the interstice.

<u>Effects of pressure in the primary pipe on the liquid level</u>

This test involved raising the pressure in the primary pipe from zero psig to 100 psig. The liquid level in the reservoir was monitored at regular intervals during this time.

1. The liquid level in the reservoir is set at the mid-point and the test apparatus is allowed to reach thermal equilibrium. The inner pipe is at ambient pressure.
2. The pressure in the inner pipe is raised from zero up to the maximum pressure specified by the piping manufacturer but not more than100 psig. The pressure should be raised in 20 psi increments.

3. The change in the volume of fluid in the reservoir is noted after each increment. This pressure is approximately twice the pressure expected at a typical service station installation.
4. Hold the pressure at the highest pressure for at least10 minutes before making the final level measurement.
5. Return the line to ambient pressure and note the final liquid level.
6. The results of the test should be displayed graphically and the volume change per psi is obtained from the slope of the line.

Effects of temperature on the liquid level

This test involves circulating hot and cold water at a constant temperature through the primary pipe. The temperature of the interstice is measured by placing a thermocouple between the bubble pack insulation and the outer pipe. The liquid level in the reservoir is measured periodically during the circulation until a constant interstitial temperature and liquid level are attained. The temperature of the circulated fluid should range from approximately 32 deg F (using ice for cooling) to 100 deg F, a temperature range of approximately 68 deg F.

The testing should be conducted as follows.

1. Circulate water at a nominal temperature of 32 deg F through the primary pipe for at least 30 minutes. This temperature should be maintained during the entire circulation period.
2. Continue circulation until the reservoir level is stable.
3. Monitor the outer wall of the interstice with a thermocouple. If manual data collection is used, data should be taken ever 5 to 10 minutes until stable readings are obtained.
4. The interstitial temperature measurement should stabilize before beginning the temperature increase.
5. This process is then repeated using water heated to a nominal temperature of 100 deg F.
6. Continue circulation until the reservoir level is stable at the higher level.
7. This process can also be conducted starting at the high temperature and going down to the low temperature.

Temperature Test With Trapped Vapor

The volume of air trapped in the pipeline system could have a significant effect on the performance of the probability of false alarm and probability of detection. If the installation is improperly sloped or the filling process has not been conducted properly, a large amount of air could be trapped in the pipeline. This test is designed to measure the effects of temperature on the reservoir level when the amount of trapped air is approximately twice the normal volume of air that might be trapped with a properly sloped and filled interstice.

Measuring the Volume of Trapped Air

The procedure for estimating the volume of trapped air is based on the compression characteristics of air relative to liquids. If no air is present in the system, a decrease in reservoir level will be due only to pipe deformation when pressure is applied. If the line is rigid, this change will be small. A large level change will occur if a large amount of air is present. A level measurement device that can be sealed in the reservoir must be used for this test.

1. Seal the reservoir with a liquid level sensor such as a magnetostrictive probe.
2. Record the level of liquid in the reservoir.
3. Pressurize the reservoir with air or nitrogen to a pressure of 10 psig.
4. Collect data until consistent readings are obtained. This should be less than 5 minutes.
5. Record the new level of liquid in the reservoir.
6. Higher pressures can be used if the pipe is rigid.
7. For flexible lines, the amount of stretch in the line must be determined and subtracted from the effects produced by compression of the trapped air.
8. Pipe deformation caused by pressure increases can be estimated by pressurizing a section of pipe without fittings that is known to be free of trapped air. This information can be used to calculate the pipe stretch correction factor for the total volume change.

The amount of trapped air is calculated from equation 1

$$(V_1 - V_2) * (P_1 - P_2) / RT = n \qquad (1)$$

where V_1-V_2 is the observed volume change in the reservoir, P_1-P_2 is the pressure added to the reservoir, R is the gas constant, T is the absolute temperature and n is the number of moles of gas in the interstice.

The number of moles of air can be converted into ml from equation 2

$$V = 22{,}400 * n \qquad (2)$$

Conducting the Trapped Air Test

1. The estimated volume of air should be introduced into the interstice in one of the horizontal sections of the pipe. An air pocket located outside the main section of pipe is not acceptable. A high point in the line should be used.
2. Hot and cold fuel are circulated through the pipeline using the same techniques as described in the “Effects of Fuel Temperature Differences”.
3. The change in volume of the interstice is again noted and the change per degree calculated.

Volume to alarm

The volume of liquid added to or removed from the reservoir that will produce an alarm will be a direct function of size of the reservoir and the spacing of the sensors. Any consistent addition or removal of liquid from the interstice (simulating a leak) will eventually produce an alarm. The volume to produce an alarm can be determined by pumping liquid into or out of the interstice using a peristaltic pump. If a sensor is present in the reservoir during the evaluation the volume to alarm can be measured directly. If the rate of addition is known, the time to alarm can also be determined. If other alternate sensors are to be used, the time to alarm must be based on the spacing of the sensors and the level change produced by the simulated change in volume, assuming that the initial liquid level is at the midpoint of the sensors. The procedure to determine the volume required to produce an alarm is as follows.

1. Adjust the initial fluid level in the reservoir to the mid-point.
2. Add or withdrawn liquid from the interstice using the peristaltic pump or other suitable device at a known rate. Several known rates can be used to obtain a direct estimate of the time to produce a specific level change
3. The removal location should be at the farthest point from the reservoir.
4. Note the volume of fluid removed to produce a known level change.
5. Adjust the level of fluid in the reservoir back to the mid-point.
6. Add liquid to the interstice using the peristaltic pump, again at a known rate. Several rates can be used to directly estimate the time to produce a specific level change.
7. Note the volume added to produce a known level change.
8. Using this information, the time to alarm for various leak rates can be readily calculated if the sensor spacing is known.

Effects of a catastrophic failure of the primary pipe

The effects of a catastrophic failure of the inner pipe should be conducted at a minimum of two locations. The first would be within three feet of the liquid reservoir and the second at a point within three feet of the far end of the test line. The catastrophic leak is produced by introducing the interstitial liquid into the interstice at a pressure of 40 psig. The level change is then observed and the change for a one-minute exposure to the catastrophic leak was determined for both locations.

1. The test line must be configured to allow the introduction of a large volume of liquid into the interstice at a nominal rate of 30 gal/m (or whatever flow rate is possible for the test line) at a pressure of 40 psi. A pressurized reservoir or a pump may be used. For narrow annular spaces the flow may be considerably below 30 gal/m. The actual flow rate should be noted.
2. The inlet for the catastrophic leak must be within 36 inches of the reservoir for one of the two tests.
3. The liquid level in the reservoir should be near the low-point at the start of the test.
4. A valve capable of allowing a flow of at least 30 gal/min into the interstice is opened rapidly.
5. The alarm system must be capable of shutting of the turbine before any liquid can escape.
6. This process must be repeated at the far end of the pipeline.

Communication through the Interstice

The rate of flow through the interstice at high pressure (40 psi) is determined using the data from the catastrophic leak tests. The volume of liquid per minute through the interstice is measured over the range of the sensors.

An additional test conducted to simulate the effects of a pinhole leak in the outer wall of the piping. This leak should be introduced into the piping as far as possible from the reservoir. The test will serve to validate the manufacturer's choice of reservoir height and interstitial monitoring fluid. This test should be conducted using the manufacturer's minimum suggested reservoir height and recommended monitoring fluid.

The size of the leak can be set by installing a needle valve at the end of the pipe furthest from the reservoir. The flow rate through the needle valve should be set at 0.1 gal/h with a pressure equal to the head pressure produced by the reservoir when it is half full. The rate of loss over time is obtained from the test time and the volume of material leaked through the needle valve. The procedure is as follows.

1. Install a calibrated needle valve at the end of the pipe furthest from the reservoir.
2. Make sure the reservoir is at the mid point between the high and low level sensors.
3. Turn on the needle valve and collect the liquid that flows out of the interstice.
4. Record the time and volume.

4.2 Leak Monitoring Equipment Characteristics

Two types of tests must be conducted to establish the characteristic of the leak detection system. These include:

- Sensor alarm set points
- Time to alarm

Reservoir level sensor alarm set points

Two approaches can be used for selecting a sensor system for the reservoir. A sensor that has already been evaluated and accepted by the NWGLDE can be used without further testing if it meets the following criteria.

- It must fit into the reservoir so that it can be easily removed for cleaning and testing;
- The set points for high and low level alarms must be appropriate for the interstitial system under evaluation. This must be determined by the third-party evaluator.
- The sensors must be compatible with the liquid in the interstice.

A list of dual point sensors can be found in the "List of Leak Detection Evaluations for Underground Storage Tank (UST) Systems," which is published periodically by the NWGLDE.[1] Any dual point sensor that has the right spacing and alarm level characteristics can be used as long as the third party evaluator provides the proper calculations for the alarm conditions.

[1] The list may be obtained from www.nwglde.org.

A second approach is to evaluate the specific sensor or sensors that can be used for the monitoring system. The procedures used to conduct the performance evaluation of level sensors are based on the methodology described for water sensor testing in the EPA ATGS protocol.[2] . These water sensor procedures have been incorporated into an alternative protocol by Ken Wilcox Associates[3] specifically for testing liquid level sensors. These specific sensors can then be used to determine the time to alarm for the system under investigation.

5.0 CALCULATIONS

The results of the testing are used to determine if the normal operating conditions in an installed line are likely to produce a false alarm. The problem of a missed detection is much less likely as the test times for producing an alarm with a relatively small breach in either wall are usually short. Any leak of measurable rate will eventually produce an alarm, probably in less than one day, before any product is lost to the environment. If the measurements in level change in the reservoir are small under the test conditions, the probability of a false alarm is low.

5.1 Primary Pipe Pressure Test

Pressurization of the primary pipe is expected to produces an increase in the liquid level, depending on the type of construction material. The pressure in the line should be increased from zero pressure to the maximum pressure for which the evaluation is valid. The liquid level in the reservoir is measured after a short time interval sufficient to let the system reach equilibrium. The level and pressure data are then obtained using equation 3

$$dL_p = (L_H - L_L) / (P_H - P_L) \qquad (3)$$

where dL_p is the level change per psi for worst-case conditions, L_H is the reservoir level at high pressure, L_L is the reservoir level at low pressure, P_H is the pressure at high level and P_L is the pressure at low level.

5.2 Temperature Tests

Two types of temperature tests are specified: With and without the presence air added to the interstitial space. Excluding the presence or absence of trapped air the two tests are identical.

<u>Temperature Test Without Added Trapped Air</u>

The calculations for the effects of temperature on the liquid level are based on Equation 3.

$$dL_T = (L_H - L_L) / (T_H - T_L) \qquad (4)$$

[2] "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", EPA/530/UST-90/006, March 1990
[3] "Alternative Test Procedures for Evaluating Leak Detection Methods: Evaluation of Liquid Level Sensors", November 1997, Ken Wilcox Associates, Inc.

where dL_T is the level change per psi for worst-case conditions, L_H is the reservoir level at high temperature, L_L is the reservoir level at low temperature, T_H is the temperature at high level and T_L is the temperature at low level.

Temperature Test With Trapped Vapor

The calculations for the effects of temperature on the liquid level with trapped air are also based on Equation 4. The results are compared with those without trapped air.

Volume to alarm

The initial liquid level in the reservoir is set at the midpoint of the high and low level sensors. The volume of fluid loss or gain in the reservoir required to trigger either a high or low-level alarm is measured directly. Product is added to or removed from a graduated cylinder until the alarm occurs. The volume in the graduated cylinder is noted at the beginning and end of the test.

Catastrophic Failure Test

The time and volume required to produce an alarm with a catastrophic leak are noted. The time at the start of the catastrophic leak and at the alarm are noted. In addition, verification that no liquid is released as a result of the leak is required. The distance from the reservoir should be noted for each test.

5.3 Extrapolation to Other Line Sizes

Extrapolation to pipelines longer than that used in the evaluation is not allowed under this protocol. The maximum allowable length (irrespective of diameter) is the same as the test line.

6.0 DISCUSSION

The use of a liquid-filled interstice for leak detection purposes is a viable method for preventing loss of product to the environment. It must be emphasized that the liquid reservoir size, initial liquid level, and spacing of the sensors are important factors for preventing nuisance alarms. These should be considered in the design of the equipment and identified by the manufacturer regarding the maximum length of pipe the reservoir and sensor will service. Any dual point sensor with dimensions that will fit into the liquid reservoir can be installed as long as it is approved by the manufacturer and has had the requisite testing described in Section 4 of this document. The sensors must then be attached to the proper monitoring equipment, which in many cases can be the ATG already installed at the test site. It is important that the high level alarm be configured to shut down the turbine immediately to prevent possible loss of product from the reservoir.

There are two types of temperature changes that could be important for this system. First, there are short-term effects from the delivery of fuel with a large temperature difference between the fuel added to the tank and the existing ground temperature. Dispensing of fuel of a different temperature can produce relatively large short-term changes in the temperature of the pipe including the interstice. This type of change is fairly fast

A second type of temperature change is a result of the slow seasonal effects that are manifested as a slow change in the ground temperature. These effects produce a slow change in the liquid level between summer and winter. The magnitude of this effect is the same as for a more rapid temperature change. Seasonal ground temperature changes are of the order of 30 deg F. The effects of both types of temperature changes can be minimized if trapped air is removed from the pipe and fittings.

Liquid level monitors will sense the cumulative effect of small leaks. They will alarm when the requisite volume of fluid is added or removed from the reservoir no matter what the time interval has been. They operate in a true continuous fashion in that they do not need to wait for quiet periods or other factors that might delay the detection of a leak. The chance of product reaching the environment using these double wall systems is as small as for other types of interstitial monitoring and have the added advantage of simple operation and low cost.

APPENDIX A

REPORTING FORMS

Results of Alternative Evaluation

Liquid Filled Interstitial Monitoring for Double-Wall Pipelines

Liquid Filled Interstitial Monitoring for Double-Wall Pipelines Liquid Filled Interstitial Monitoring for Double-Wall Pipelines

This form tells whether the pipeline tightness testing method described below complies with the performance requirements of the federal underground storage tank regulation. The evaluation was conducted by an independent testing organization for the manufacturer according to the guidelines established for alternative protocols described in the preface to the U.S. EPA'S "Standard Test Procedure for Evaluating Leak Detection Methods: Nonvolumetric Tank 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 prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

Method Description

Name ____

Version ____

Vendor ____

____
(street address)

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

Evaluation Results

This method, which declares a pipeline to be leaking when__________________

____

____

Volume to alarm is ____ gallons. (based on reservoir volumes)

Pipeline and Reservoir Characteristics

The characteristics of the pipeline used in this evaluation are summarized in Table 1.

Table 1 Pipeline Characteristics

Parameter	Value
Line Length	
Primary Pipe Diameter	
Volume of Primary Pipe	
Secondary Pipe Diameter	
Interstitial Space	
Volume of Interstice	

The pipeline construction material was ( ) steel ( ) fiberglass ( ) flexible materials.

The dimensions of the reservoir are approximately _________ inches tall and ___________ inches in diameter with a cross section surface area of approximately ____________ square inches.
The capacity of the liquid reservoir is approximately ________ gallons
The liquid in the interstice was ________.
The sensor spacing used to measure the reservoir level alarms is ________ inches.

The sensor operating principle is ____
____

The approximate volume change to produce an alarm was calculated to be _____ ml when the float is initially at the midpoint of the reservoir.

The sensor(s) was previously evaluated ( ) yes ( ) no ( ) not included in evaluation

If so, reference the evaluation ____
____

Pressure Test

The results of the pressure tests are shown in Table 2.

Table 2. Pressure Data

Parameter	**Value**
Initial Pressure	
Final Pressure	
Difference	
Gal/psi	

Temperature Effects Without Trapped Vapor

The results of the temperature tests without trapped vapor are shown in Table 3.

Table 3 Temperature Data Without Trapped Vapor

Parameter	**Value**
Initial Temperature	
Hot Temperature	
Cold Temperature	
Difference	
Temperature Effect (in/Deg F	

Comments ____
____

Temperature Effects With Trapped Vapor

The volume of air trapped in the interstice was _______ ml. The results of the testing with trapped vapor are shown in Table 4.

Table 4. Temperature Data With Trapped Vapor

Parameter	**Value**
Initial Temperature	
Hot Temperature	
Cold Temperature	
Difference	
Temperature Effect (In/Deg F)	

Comments ____
____

Effects of a Catastrophic Leak

The test data for a catastrophic leak are shown in Table 5.

Table 5. Catastrophic Leak Data

Parameter	**Value**
Distance from the Reservoir	
Pressure at Leak Inlet	
Measured Flow Rate	
Time to Produce an Alarm	

Communication Through the Interstice

The test data for a small leak in the secondary containment is shown in Table 6. The orifice used to generate the leak allowed a flow of 0.1 gal/h with a reservoir head pressure of _______ inches of interstitial fluid.

Table 6. Communication Data

Parameter	Value
Distance of leak from the Reservoir	
Pressure at Leak Inlet	
Measured Flow Rate	
Time to Produce an Alarm	

Volume to Alarm

For a level change of ___________ inches (half of the distance between the high and low level alarm set points) the volume change is____________ gal.

Limitations on the Results

The performance estimates above are only valid when:

- The liquid in the reservoir must be at least ____ inches above the water table, if present so that groundwater cannot enter the interstitial space.
- The method has not been substantially changed.
- The vendor's instructions for using the method are followed.

  The maximum line length for this system is ______ feet.
- The sensor spacing must be at least _________inches.

If this method is affected by other sources of interference, list these interferences below and give the ranges of conditions under which the evaluation was done. (Check None if not applicable.)

( ) None

Interferences	Range of Test Conditions
____________________	____________________
____________________	____________________
____________________	____________________

Maintenance requirements specified by the vendor or determined during testing:

____

____

____

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

Certification of Results

I certify that the liquid filled interstitial test testing method was installed and operated according to the vendor's instructions. I also certify that the evaluation was performed according to the alternative EPA test procedure “Test Procedure for the Evaluation of Double Wall Pipe With Liquid Filled Interstice for Loss Prevention”, and that the results presented above are those obtained during the evaluation.

______________________________	. ______________________________
(printed name)	(organization performing evaluation)
______________________________	______________________________
(signature)	(city, state. zip)
______________________________	______________________________
(date)	(phone number)

Description

Liquid Filled Interstitial Monitoring for Double-Wall Pipelines

This section describes briefly the important aspects of the nonvolumetric tank tightness testing method. It is not intended to provide a thorough description of the principles behind the method or how the equipment works.

Method Name and Version

____

____

____

____

____

____

Does this system use a liquid reservoir for monitoring?

( ) yes

( ) no

If yes, what type of liquid is used? ____________________________

Pipeline Characteristics

Pipeline construction material allowed

( ) steel

( ) fiberglass

( ) other

Maximum allowable line size ____

Interstitial volume ____________

Reservoir volume ____________ gallons

High-level alarm occurs at ___________ inches

Low-level alarm occurs at _________ inches

Equipment Interface

Is this equipment interfaced with other leak detection equipment such as an Automatic Tank Gauge?

( ) yes

( ) no

If so, what types of equipment are acceptable?

( ) control unit provided by manufacturer
( ) automatic tank gauge
( ) other console provided by another vendor
( ) other (describe) ______________________________

What type of sensor is used to detect liquid volume changes?

( ) float switches
( ) optical sensors
( ) pressure
( ) ultrasonic
( ) other (describe) ______________________________
____

Product

> Product type

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

( ) gasoline
( ) diesel
( ) aviation fuel
( ) fuel oil #4
( ) solvents
( ) waste oil
( ) other (list) ______________________________

>Response to an Alarm

What happens when an alarm occurs?

( ) A signal is sent to the control unit
( ) The turbine is shut down
( ) user defined response (describe) ______________________________

> **Principle of Operation (check all that apply)**

What principle or principles are used to identify a leak? (check all that apply)

( ) Loss of liquid from the monitoring reservoir

( ) Increase in liquid in the monitoring reservoir

( ) other (describe briefly) ____

Temperature Measurement

Are temperature measurement used by this method?

( ) yes

( ) no

If yes, describe how they are used. _________________________________

Procedure Information

> Total volume change

What is the total volume change needed to produce an alarm with this method?

______________ gallons

> Other important elements of the procedure or method

List here any other elements that could affect the performance of the procedure or method (e.g., distance between reservoir and leak, ambient temperature fluctuations etc.)

.____

____

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> Identifying and correcting for interfering factors

How does the method determine the presence and level of the ground water above the pipeline?

( ) observation well

( ) other (describe briefly) ____

( ) Level of ground water above bottom of the pipeline not determined

How does the method correct for the interference due to the presence of ground water above the bottom of the tank?

( ) head pressure increased by raising the level of the liquid reservoir

( ) other (describe briefly)____

____

( ) no action

How does the method identify the presence of vapor pockets?

( ) vapor pockets are not a problem for this system

( ) large fluctuations in level

( ) other (describe briefly) ____

____

( ) not identified

( ) not applicable

How does the method correct for the presence of vapor pockets?

( ) purge vapor from the interstice

( ) presence of vapor is not a problem

( ) other (describe briefly) ___________________________________.______

( ) not applicable

If not, how often are the sensors calibrated?

( ) factory calibration before installation

( ) yearly or less frequently

( ) never

> Interpreting test results

What effect is used to declare the pipeline to be leaking? (List all modes used by the method.)

______.____

____

____

If a change in volume is used to detect leaks, what threshold value for product volume change (gallon per hour) is used to declare that a pipeline is leaking?

( ) cumulative loss or gain of liquid in the reservoir

( ) other ____

Exceptions

Are there any conditions under which this system should not be installed?

( ) reservoir cannot be located at least 12 inches above ground water

( ) ground-water level above bottom of pipeline

( ) presence of vapor pockets in the interstice

( ) extremely high or low ambient temperature

( ) invalid for some products (specify) __________________________

( ) other (describe briefly) __________________________________

What are acceptable deviations from the standard testing protocol?

( ) none

( ) lengthen the duration of test

( ) other (describe briefly) __________________________________

What elements of the test procedure are left to the discretion of the testing personnel on-site?

( ) determination of presence of vapor pockets

( ) adjustment of liquid level in reservoir

( ) other (describe briefly) __________________________________

( ) none