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

Draft

PREPARED By:

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May 27, 2003

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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.

Peer Review of this Document

This document has been sent to the following persons for review.

Independent Consultants
Jack Quigley – Peer Review Coordinator and Engineer, University of Wisconsin
Jerry Flora – Independent Consultant - statistician
Jeff Wilcox – Engineer for KWA
Wayne Hill – Consultant with extensive petroleum handling experience
Vendors and Users
Joie Folkers – Ameron
Dan McGill – Wayne Perry
Jim Goodman – Beaudreau Electric
Jonathan Stong – Environ
Tony Adamson – Total Containment
Others as needed

Other persons wishing to participate in this review may do so. Please notify KWA if you wish to be included in the review.

Workgroup Members for Preliminary Review Only
Tim Smith – USEPA, Office of Underground Storage Tanks
Mike Kadri – State of Michigan
Sharon Sadlon – State of Alaska
Curt Johnson – State of Alabama, Workgroup Chairman
Scott Bacon – State of California

If you have received this document in error or do not wish to participate, please disregard.

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 has been 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. Volunteers for peer review should contact Ken Wilcox at 816-443-2494.

Ken Wilcox, President
Ken Wilcox Associates, Inc.

May 27, 2003

Table of Contents

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. The test data is contained in Appendix B. .

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. This protocol describes testing that can be easily accomplished 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 itself are determined. Second, the characteristics of the leak detection system as it is installed in the pipeline are considered.

One potential problem 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 for pipelines at service stations.

Because the number of tests proposed for this protocol is limited, the worst-case conditions a

2.0 APPLICABILITY

This procedure can be used to test any doubly contained pipeline system with a liquid filled interstice that has 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.

3.0 TEST APPARATUS

Construction of Test Line

To conduct these tests, a short section of pipeline provided by the pipeline manufacturer must be constructed for use in a laboratory environment. It should be constructed of the same types of materials as are used in a field installation and consist with the types of connectors used in an actual installation. The pipeline must be at least 20 feet in length. The number of connectors should be consistent with the number expected for the length of the test apparatus. A diagram of such a test apparatus is shown in Figure 1.

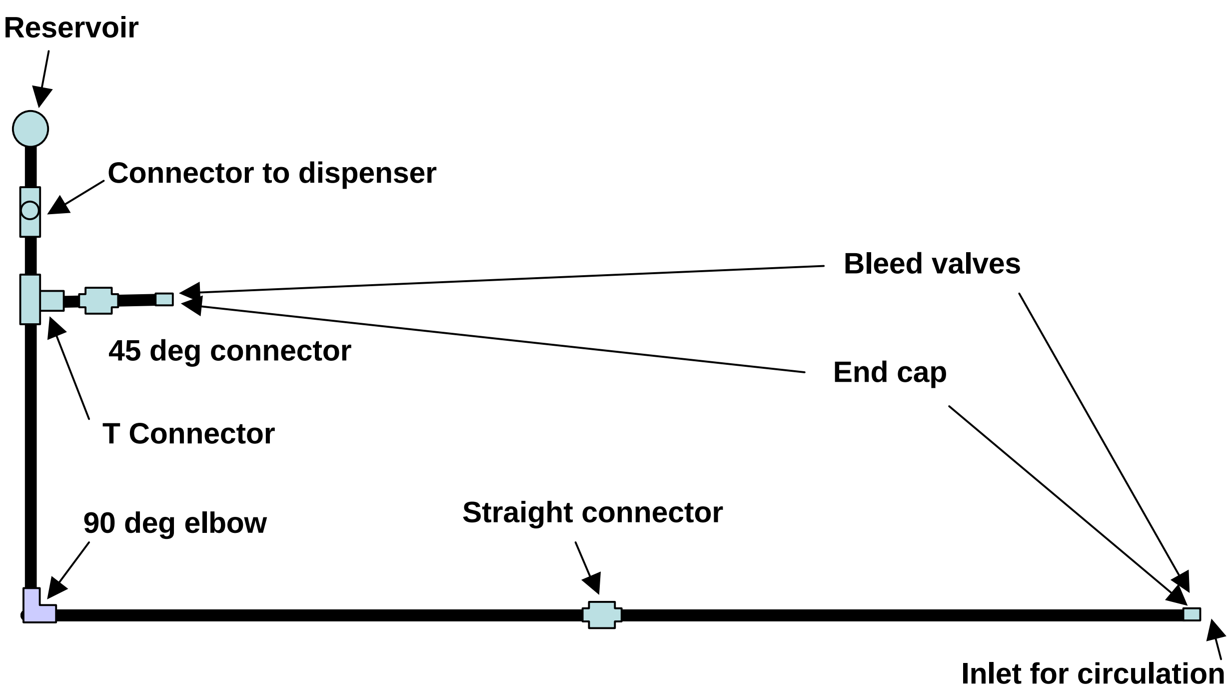

Figure 2. Schematic of Pipeline Assembly used in Evaluation (Top View)

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 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

Heating and cooling

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 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 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 over the time period from the start of the leak until 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 various 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

A known quantity of air can be injected into the pipeline using a syringe or other equivalent method. The total volume of air introduced should be around 300 ml, irrespective of the size of the test pipeline.

Temperature measurements

Temperature measurements should be made to 0.1 deg F using a temperature device with an accuracy of 2 deg F. The accuracy is less important than the resolution, but all temperature devices should be calibrated to within 2 deg of each other. Temperature measurements should be taken in the circulation reservoir and on the outside of the interstice under the insulation somewhere near 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.

4.0 DESCRIPTION OF EVALUATION PROCEDURES

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

Pipeline Characteristic Tests

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

- 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 briefly below.

Effects of pressure in the primary pipe on the liquid level

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 10 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 are 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) 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.
4. The interstitial temperature measurement should stabilize before beginning the temperature increase.
5. When the temperature is stable, the temperature of the water should be raised to the upper temperature.
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

This testing is conducted with 300 ml of air trapped in the pipeline interstitial space. The same type of testing is conducted with the trapped air as is conducted for the pipeline without trapped air.

The procedure for testing with trapped air is as follows.

1. Approximately 300 ml of air should be introduced into the interstice at some convenient point of the test apparatus.
2. Since temperature is expected to be one of the most influential processes the air must be in a horizontal section of the interstice at a location where it is near the

inner pipe. An air pocket located outside the main section of pipe is not acceptable. A high point in the line should be used.

3. Hot and cold fuel is circulated through the pipeline using the same techniques as described in the “Effects of Fuel Temperature Differences”.
4. The change in volume of the interstice is again noted and the change per degree calculated.

Volume to alarm

The volume required to 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 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. Addition of liquid to the interstice can be accomplished using a needle valve and flow meter.
2. Liquid is added or withdrawn from the interstice using the peristaltic pump.
3. Note the volume of fluid removed to produce a low level alarm.
4. A breach in the inner wall can be simulated by pumping liquid into the interstice at the point farthest from the reservoir.
5. Note the volume added to produce the high level alarm.

While testing with a known amount of trapped air is indicative of the effect of a specific volume of air, it can be difficult to extrapolate the information to longer lines. Depending on the design of the pipeline system, the amount of trapped air may or may not be directly proportional to the line length or volume. The evaluator must take into consideration the number and types of fittings in a normal installation. Flexible lines consisting of long continuous sections without fittings are less likely to trap air than are shorter sections of rigid pipe with more connectors.

Effects of a catastrophic failure of the primary pipe

The effects of a catastrophic failure of the inner pipe should be conducted at two locations. The first would be close to the liquid reservoir and the second at a point near the end of the test line. Additional locations may also be tested. 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 40 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 40 gal/m. The actual flow rate should be noted.

2. The inlet for the catastrophic leak must be within 24 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 anyliquid can escape.

<u>Communication through the interstice</u>

The rate of flow through the interstice 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.

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

<u>Reservoir level sensor alarm set points</u>

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," that 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.

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

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[1] The list may be obtained from www.nwglde.org.
[2] "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", EPA/530/UST-90/006, March 1990

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.

4.0 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 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.

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 at ten-psi increments and the liquid level in the reservoir measured after short time interval sufficient to let the system reach equilibrium. The level and pressure data are then plotted using a standard spreadsheet. The slope of the line can be used to estimate the effects of pressure on the level. If a smooth slope is not obtained, the worst case conditions must be used according to equation 1

$$dL_p = (L_H - L_L) / (P_H - P_L) \qquad (1)$$

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.

Temperature Tests

Two types of temperature tests are specified: With and without the presence air added to the interstitial space. Other than the presence or absence of trapped air the two methods 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 2.

$$dL_T = (L_H - L_L) / (T_H - T_L) \qquad (2)$$

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.

[3] "Alternative Test Procedures for Evaluating Leak Detection Methods: Evaluation of Liquid Level Sensors", November 1997, Ken Wilcox Associates, Inc.

Temperature Test With Trapped Vapor

The calculations for the effects of temperature on the liquid level with trapped air are also based on Equation 2. 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.

Extrapolation to Other Line Sizes

The vendor may want to apply the system to line sizes other than the one used in the evaluation. The extrapolation can be applied to any line size as long as the effects of temperature, pressure and trapped air do not cause a false alarm. Extrapolation is normally linear, but may be altered by the evaluator if the line characteristics suggest that linear extrapolation is inappropriate.

5.0 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 more important 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.

Pipeline and Reservoir Characteristics

The evaluation testing was conducted in a pipeline with a capacity of _____ gallons with an inside diameter of _____ inches and a length of ____ ft.
The pipeline construction material was ( ) steel ( ) fiberglass ( ) flexible materials.

The capacity of the liquid reservoir is approximately ________ gallons
The dimensions of the reservoir are approximately _________ inches tall and ____________ inches in diameter with a cross section surface area of approximately ____________ square inches.

The liquid in the interstice was ________.
The sensor spacing used to measure the reservoir level alarms is ________ inches for a pipeline length of _______ ft.

The sensor operating principle is ______________________________________
____

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

The sensor(s) was previously evaluated (   ) yes ( ) no.

If so, reference the evaluation ____________________________________
____

Pressure Test

The tests were conducted with the primary line pressurized to ______ psi.
The worst-case level change in the liquid reservoir was observed to ______ inches per psi change in pressure from ______ psi to ______ psi.

The liquid used to pressurize the primary pipe was ______________.

Test Data

	Pressure (psi)	Level (in)
Initial Pressure	___________	___________
Final Pressure	___________	___________
Difference	___________	___________
Slope (optional)	___________	___________
Press. Effect (In/psi)	___________	___________
Press. Effect (In/psi/ft)	___________	___________

Temperature Effects Without Trapped Vapor

	Temp. (Deg F)	Level (in)
Initial	___________	___________
Hot	___________	___________
Cold	___________	___________
Difference	___________	___________
Temp Effect (In/Deg F)	___________________________	
Temp. Effect (In/Deg F/Ft)	___________________________	

Comments ____
____

Temperature Effects With Trapped Vapor

The volume of air trapped in the interstice was _______ ml.

	Temp. (Deg F)	Level (in)
Initial	___________	___________
Hot	___________	___________
Cold	___________	___________
Difference	___________	___________
Temp Effect (In/Deg F)	___________________________	
Temp. Effect (In/Deg F/Ft)	___________________________	

Comments ____
____

Effects of a Catastrophic Leak

The rate of flow through the interstice at a distance of ______ ft from the reservoir was ______ gal/min at a pressure of ______ psi. At this flow rate, the time to produce an alarm is __________ minutes.

The rate of flow through the interstice at a distance of ______ ft from the reservoir was ______ gal/min at a pressure of _______ psi. At this flow rate, the time to produce an alarm is ____________seconds.

Volume to Alarm

For a Level change of __________ inches

The volume to produce an alarm in the primary pipe is ______ gal.
The volume to produce an alarm in the secondary pipe 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 with a primary pipe size of ______ inches in diameter.
- 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:

______

______ .

______

Extrapolation to Other Line Sizes

	Evaluation Line	Line 1	Line 2
Length	______	______	______
Diameter	______	______	______
Interstitial Vol. (gal)	______	______	______
Pressure Effects	______	______	______
Temp w/o vapor	______	______	______
Temp with vapor	______	______	______

> 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.

H. Kendall Wilcox
(printed name)

______
(signature)

______
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Grain Valley, MO 64029
(city, state. zip)

______
(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.)

. ____

____

____

____

> 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