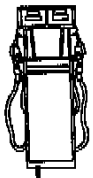

# Evaluation of the FE Petro STP-MLD-E Line Leak Detector For Hourly Monitoring on Flexible Pipelines

Final Report

PREPARED FOR:

**FE Petro, Inc.**

March 24, 1994

KWA

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**P.O Box 139**
**McFarland, WI 53558**

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## Preface

The data contained in this report were obtained from the FE Petro STP-MLD-E Line Leak Detector when operated as an Hourly Monitor on flexible pipelines. The test results are based on data collected using the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Pipeline Leak Detection Systems", EPA/530/UST-90/010. The work was conducted at the Leak Detection Test Center which is operated by Ken Wilcox Associates, Inc. Questions should be directed to Mr. Don Kenney, FE Petro, Inc., at (608) 838-8786.

KEN WILCOX ASSOCIATES, INC.

H. Kendall Wilcox

H. Kendall Wilcox, President

March 24, 1994

## Table of Contents

## Executive Summary

This report presents the results of the evaluation of the STP-MLD-E Line Leak Detector on flexible pipelines. The test procedures used were those described in the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Pressurized Pipeline Leak Detection Systems," EPA/530/UST-90/010, September 1990. The testing was conducted at an instrumented test facility using Option 1 as described in the EPA protocol. Testing was conducted at rates equivalent to 3 gal/h at 10 psi (for Hourly Testing). Fifty-three tests were conducted during the evaluation including three tests with vapor in the line.

For Hourly Testing, the probability of a false alarm for the leak detection mode is 0% and the probability of detecting a leak is 100%. These performance parameters exceed the EPA requirements for hourly line tightness testing.

The formal results of the evaluation are reported on the official EPA forms in Attachment A of this report.

## Introduction

This report presents the evaluation of the FE Petro STP-MLD-E Line Leak Detector on flexible pipeline. It contains an overview of the EPA Protocol used for testing, a description of the equipment being tested, a description of the test site and operating procedures, and a test results summary. The detailed results of the testing are presented in Attachment A using the forms provided in the EPA protocol.

## Overview of EPA Test Protocol

The U.S. Environmental Protection Agency (EPA) has specified that certain performance criteria be met for leak detection equipment used on underground storage tanks and pipeline systems containing petroleum products. These criteria are described in 40CFR Part 280, Subpart D of the Code of Federal Regulations.

To demonstrate that a leak detector meets the performance criteria, the EPA has also produced an evaluation protocol for the different types of line leak detectors entitled "Standard Test Procedures for Evaluating Leak Detection Methods: Pipeline Leak Detection Systems". Except for the bulk modulus, the testing described in this report was conducted using the procedures prescribed in the protocol for evaluating hourly line leak detector systems. The EPA protocol specifies that testing must be conducted on pipelines with a bulk modulus between 15,000 and 35,000 psi/ml. The purpose of this particular testing was to evaluate the performance of the STP-MLD-E leak detector on low bulk modulus pipelines. Flexible pipelines are typically well below the minimum bulk modulus. Enviroflex pipeline was used during this evaluation which had a bulk modulus of 1,280 psi.

Basic requirements of the hourly protocol to be met are that the leak detector be capable of detecting a leak greater than 3 gal/hr in less than one hour with a probability of detection ($P_D$) greater than 95% and a probability of false alarm ($P_{FA}$) less than 5%. These values must be maintained under noise conditions expected in normal operation, principally thermal contraction and thermal expansion of the fuel in the pressurized pipeline. Additional testing is required to check the leak detector's reaction to vapor trapped in the pipeline, since vapor may affect the equipment's reaction to leaks.

EPA protocol offers several alternative approaches to the evaluation of line leak detectors. The standard approach of testing at a specialized test facility (Option 1) was used for this evaluation. This procedure requires that a minimum of 25 tests be conducted under no leak conditions and 25 tests at a leak rate of 3 gal/hr. Each series of tests is conducted under a range of temperature conditions which are designed to test the ability of the leak detection equipment to identify and deal with the problems caused by severe temperature behavior and the vapor pockets previously discussed. For this option, the evaluation was conducted under controlled conditions at the Leak Detection Test Center located in Kansas City, Missouri.

## Description of the STP-MLD-E Mechanical Line Leak Detector

The STP-MLD-E leak detector is a mechanical system that incorporates a popet valve and metering pin. When the pump is activated, fuel is metered into the line to raise the pressure. If the pressure rises above 15 psi, the popet valve opens and full flow into the line occurs. If the pressure fails to rise above 15 psi, fuel flow in the line is restricted to approximately 2 gal/min.

## Overview of the Test Site and Operating Procedures

Testing was conducted on a 270 ft, two-inch diameter Enviroflex pipeline manufactured by Total Containment. The volume of the line was 24.8 gal and the bulk modulus 1,280 psi/ml.

A 560 gallon reservoir equipped with a submerged pump was used to circulate product through the test line. Product temperatures in the reservoir tank were adjusted by circulating heated or cooled glycol through cooling coils which were located in the tank.

The temperature of the product in the tank was monitored as well as the soil temperatures around the pipeline using RTD's which were calibrated against an NBS traceable thermometer. These temperatures were used to determine the temperature differential between the product in the tank and the soil using the equations outlined in the EPA protocol.

Leaks were simulated by calibrating a needle valve and variable area flowmeter to deliver the desired leak (nominally 3.0 gal/hr at a pressure of 10 psi as required by the regulations). Once the calibration was complete, no further adjustments were made in the valve which was connected to the line to simulate the leak. The leak rate would, of course, vary as the pressure on the line changed during the test.

Two types of tests were conducted: Tests with a leak of 3 gal/hr were used to test the ability of the STP-MLD-E to detect leaks under a variety of temperature conditions; and tests with no leaks were used to confirm a low probability of false alarms on a tight line, again under a variety of temperature conditions. A brief summary of the testing procedures is as follows:

1) The STP-MLD-E was installed according to the manufacturer's specifications.

2) The product in the reservoir tank was adjusted to the desired temperature range.

3) Product was circulated through the line for one hour at a rate of approximately 20 gal/min.

4) For a test involving a leak, a leak rate of 3.0 gal/hr at 10 psi was introduced into the line during the circulation period. For a non-leak test, the product was only circulated.

5) At the end of the circulation period the dispenser nozzle was closed and the pump was turned off. The pressure was then dropped to zero by bleeding product from the line through a small valve. This process reset the STP-MLD-E to the leak detect mode. This process took approximately two minutes.

6) The pressure bleed valve was then closed with the leak still present in the line. For a non-leak situation, the bleed valve was closed when the pressure reached zero.

7) With the dispenser nozzle in the closed position, the pump was turned on. If the line pressure rose to full pump pressure (approximately 28 psi) within 5 minutes, a non-leaking line was indicated. If the pressure did not rise to 28 psi within 5 minutes, the leak detector was assumed to have reported a leak.

8) Since the test times were short, the testing sequence was repeated at least three times for each circulation period by repressurizing the line (without additional circulation) and repeating steps 5 through 7.

Only four types of results were possible. First, a leaking line found to be leaking (a correct conclusion). Second, a non-leaking line is found to be tight (a correct conclusion). Third, a leaking line is found to be tight (a missed detection) and fourth, a tight line is reported to be leaking (a false alarm). The results of each test were recorded and compared to the correct conclusion.

**Test Results Summary**

The results of the testing are summarized in Table 1 and in the results forms provided in the EPA protocol. These forms have been reproduced in Attachment A. The performance parameters for the STP-MLD-E systems have been summarized in Table 2.

A total of 53 tests were conducted using the EPA evaluation protocol. These were divided into 25 leak tests, 25 no-leak tests, and 3 vapor tests. No failures were recorded during the evaluation. The leaks tabulated were detected and no false alarms occurred with the "zero leaks". Since the time period for data collection was short, (approximately 5 minutes were required) up to three tests could be conducted for each temperature condition as discussed in Section 5.2 of the protocol.

Since there were no missed detections or false alarms, the probability of detection of a leak of 3 gal/hr is 100% and the probability of a false alarm is 0%. The average time to open to full flow for a tight line was 1 minute. The time to open was largely independent of the product temperature.

**Discussion**

The single most important characteristic of flexible pipeline is the stretch produced when the line is pressurized with product as indicated by a low bulk modulus. The volume of the line used in this

**Table 1. Data Sheet Summarizing the Test Results and the Leak Rates Used in the Evaluation**

| Test No. (Based on Temperature | Date Test Began | Induced Leak Rate @ 10 psi | Time between End of Circulation and Start of Data Collection for Test | Time Data Collection Began | Time Data Collection Ended | Test Result | Was Threshold Exceeded? |
|---|---|---|---|---|---|---|---|
| | (D-M-Y) | (gal/hr) | (h-min) | (military) | (military) | (leak or tight) | (yes or no) |
| 1 | 24-01-94 | 0 | 1 min | 1147 | 1150 | tight | no |
| 2 | 24-01-94 | 2.69 | 4 min | 1150 | 1154 | leak | yes |
| 3 | 24-01-94 | 0 | 1 min | 1302 | 1305 | tight | no |
| 4 | 24-01-94 | 2.69 | 4 min | 1305 | 1309 | leak | yes |
| 5 | 24-01-94 | 0 | 9 min | 1310 | 1313 | tight | no |
| 6 | 24-01-94 | 0 | 1 min | 1420 | 1423 | tight | no |
| 7 | 24-01-94 | 2.69 | 4 min | 1423 | 1427 | leak | yes |
| 8 | 24-01-94 | 2.69 | 1 min | 1541 | 1545 | leak | yes |
| 9 | 24-01-94 | 0 | 4 min | 1546 | 1549 | tight | no |
| 10 | 24-01-94 | 2.69 | 9 min | 1549 | 1553 | leak | yes |
| 11 | 24-01-94 | 0 | 1 min | 1711 | 1714 | tight | no |
| 12 | 24-01-94 | 2.69 | 4 min | 1714 | 1718 | leak | yes |
| 13 | 24-01-94 | 0 | 9 min | 1719 | 1722 | tight | no |
| 14 | 24-01-94 | 2.69 | 1 min | 1825 | 1829 | leak | yes |
| 15 | 24-01-94 | 0 | 6 min | 1830 | 1833 | tight | no |
| 16 | 25-01-94 | 2.69 | 10 min | 0745 | 0749 | leak | yes |
| 17 | 25-01-94 | 0 | 15 min | 0750 | 0752 | tight | no |
| 18 | 25-01-94 | 2.69 | 1 min | 0955 | 0959 | leak | yes |
| 19 | 25-01-94 | 0 | 6 min | 1000 | 1003 | tight | no |
| 20 | 25-01-94 | 2.69 | 9 min | 1003 | 1007 | leak | yes |
| 21 | 25-01-94 | 0 | 2 min | 1514 | 1516 | tight | no |
| 22 | 25-01-94 | 2.69 | 6 min | 1518 | 1522 | leak | yes |
| 23 | 26-01-94 | 0 | 1 min | 1005 | 1008 | tight | no |
| 24 | 26-01-94 | 2.69 | 5 min | 1009 | 1013 | leak | yes |
| 25 | 26-01-94 | 0 | 9 min | 1013 | 1015 | tight | no |
| 26 | 26-01-94 | 2.69 | 1 min | 1159 | 1203 | leak | yes |
| 27 | 26-01-94 | 0 | 5 min | 1203 | 1206 | tight | no |
| 28 | 26-01-94 | 2.69 | 9 min | 1207 | 1211 | leak | yes |
| 29 | 26-01-94 | 0 | 1 min | 1506 | 1509 | tight | no |
| 30 | 26-01-94 | 2.69 | 5 min | 1510 | 1514 | leak | yes |
| 31 | 26-01-94 | 2.69 | 1 min | 1717 | 1721 | leak | yes |
| 32 | 26-01-94 | 0 | 6 min | 1722 | 1725 | tight | no |
| 33 | 27-01-94 | 2.69 | 1 min | 0851 | 0856 | leak | yes |
| 34 | 27-01-94 | 0 | 6 min | 0856 | 0859 | tight | no |
| 35 | 27-01-94 | 2.69 | 10 min | 0900 | 0905 | leak | yes |
| 36 | 27-01-94 | 0 | 1 min | 1139 | 1142 | tight | no |
| 37 | 27-01-94 | 2.69 | 4 min | 1142 | 1146 | leak | yes |
| 38 | 27-01-94 | 0 | 1 min | 1300 | 1302 | tight | no |
| 39 | 27-01-94 | 2.69 | 4 min | 1303 | 1307 | leak | yes |
| 40 | 27-01-94 | 0 | ^ 9 min | 1308 | 1311 | tight | no |
| 41 | 17-02-94 | 0 | 1 min | 0335 | 0337 | tight | no |
| 42 | 17-02-94 | 2.69 | 3 min | 0337 | 0341 | leak | yes |
| 43 | 17-02-94 | 2.69 | 1 min | 0449 | 0453 | leak | yes |
| 44 | 17-02-94 | 0 | 6 min | 0454 | 0456 | tight | no |
| 45 | 17-02-94 | 2.69 | 8 min | 0456 | 0500 | leak | yes |
| 46 | 17-02-94 | 2.69 | 1 min | 0605 | 0609 | leak | yes |
| 47 | 17-02-94 | 0 | 6 min | 0610 | 0612 | tight | no |
| 48 | 17-02-94 | 0 | 1 min | 0716 | 0718 | tight | no |
| 49 | 17-02-94 | 2.69 | 3 min | 0718 | 0722 | leak | yes |
| 50 | 17-02-94 | 0 | 8 min | 0723 | 0725 | tight | no |

**Table 2. Performance Parameters for the STP-MLD-E Line Leak Detector**

| Parameter | Value |
|---|---|
| Hourly Testing (3 gal/h) | |
| Probability of Detection ($P_D$) | 100% |
| Probability of False Alarm ($P_{FA}$) | 0% |
| Maximum Line Size | 49.6 gallons |
| Average Time to Open (Tight Line) | 2 minutes 38 seconds |

evaluation was 24.8 gal with a bulk modulus of 1280 psi. This produces a dramatic effect on the time required to conduct a test, the reset time for the system, and on the effects of temperature changes on the line pressure. Fortunately, there are some beneficial tradeoffs which can be obtained from a properly engineered leak detector.

Test Time

The time for the STP-MLD-E to reach full flow position on a tight line increased from a nominal time of less than one minute on a rigid line to 2 minutes 38 seconds on flexible pipeline. This would be a nearly intolerable interval if it occurred every time the pump was activated. In practice, because of the expansion characteristics of the line, the leak detector will not normally reset between usages unless there is a leak in the line. If the leak detector does not reset, the time to open is not important. Product may be dispensed at any time after the pump is activated.

Thermal Contraction Effects

Thermal contraction is a potential source of problems for mechanical line leak detectors. For rigid lines such as FRP or steel, thermal changes of only one or two degrees are capable of causing the leak detector to reset. If the contraction continues during the metering period a false alarm can occur.

With the large expansion effects of flexible lines the contraction for a 150 ft, 2 in diameter line must exceed 0.4 gallons before the pressure will drop low enough to cause the leak detector to reset. The volume of product contained in 150 feet of Enviroflex line is nominally 14 gallons. To produce a contraction of 0.4 gallons, the temperature of the product in the line would need to decrease by 38 deg. F. This will almost never happen, reducing the problem of false alarms to a negligible level.

Maximum Line Size

The EPA regulations allow line leak detectors to be used on lines up to twice the volume contained in the line under which they were tested. The line used for this evaluation was 270 ft in length long and nominally 2 in in diameter. The volume of the line was determined to be 24.8 gal. The maximum size flex line that can be tested with the STP-MLD-E is 49.6 gal.

## Conclusions

The following conclusions and recommendations are based on the results of the testing described in this report.

1) The performance of the FE Petro STP-MLD-E Line Leak Detector exceeds the EPA performance requirements for hourly monitoring.

2) Since there were no missed detections or false alarms, the Probability of Detection ($P_D$) is 100%. (The EPA requirements for $P_D$ are 95% or higher.)

3) The Probability of a False Alarm (PFA) is 0%. (The EPA requirements for $P_{FA}$ are 5% or less.)

4) No noticeable effects were observed when trapped vapor was present.

5) The test times were independent of temperature.

6) The STP-MLD-E systems has een evaluated for use on flexible pipelines up to a capacity of 49.6 gallons.

# Attachment A

# EPA Forms for the STP-MLD-E Line Leak Detector for Hourly Monitoring on Flexible Pipelines

# Results of the Performance Evaluation Conducted According to EPA Test Procedures

**Pipeline Leak Detection System**
**Used as an**
***Hourly Monitoring Test***

This form summarizes the results of an evaluation to determine whether the pipeline leak detection system named below and described in Attachment 1 complies with federal regulations for conducting an hourly monitoring test. The evaluation was conducted according to the United States Environmental Protection Agency's (EPA's) evaluation procedure, specified in *Standard Test Procedures for Evaluating Leak Detection Methods: Pipeline Leak Detection Systems.* The full evaluation report includes seven attachments.

Tank system owners who use this pipeline leak detection system should keep this form on file to show compliance with the federal regulations. Tank system owners should check with state and local agencies to make sure this form satisfies the requirements of these agencies.

## System Evaluated

System Name: FE Petro STP-MLD-E

Version of System: STP-MLD-E

Manufacturer Name: FE Petro, Inc.

P.O. Box 139
(street address)

McFarland, WI 53558
(city, state, zip code)

(608) 838-8786
(telephone number)

## Evaluation Results

1. The performance of this system
   (X) meets or exceeds
   ( ) does not meet
   the federal standards established by the EPA regulation for hourly monitoring tests.

   The EPA regulation for an hourly monitoring test requires that the system be capable of detecting a leak as small as 3 gal/h with a probability of detection ($P_D$) of 95% and a probability of false alarm ($P_{FA}$) of 5%.

2. The estimated $P_{FA}$ in this evaluation is 0 % and the estimated $P_D$ against a leak rate of 3 gal/h defined at a pipeline pressure of 10 psi in this evaluation is 100 %.

## Criterion for Declaring a Leak

3. This system
(X) uses a preset threshold
( ) measures and reports the output quantity and compares it to a predetermined threshold to determine whether the pipeline is leaking.

4. This system
(X) uses a single test
( ) uses a multiple-test sequence consisting of _____ tests (specify number of tests required) separated by _____ hours (specify the time interval between tests) to determine whether the pipeline is leaking.

5. This system declares a leak if the output of the measurement system exceeds a threshold of 2.0 gal/h (specify flow rate in gal/h) in 1 out of 1 tests (specify, for example, 1 out of 2, 2 out of 3). If more detail is required, please specify in the space provided.

## Evaluation Approach

6. There are five options for collecting the data used in evaluating the performance of this system. This system was evaluated

(X) at a special test facility (Option 1)
( ) at one or more instrumented operational storage tank facilities (Option 2)
( ) at five or more operational storage tank facilities verified to be tight (Option 3)
( ) at 10 or more operational storage tank facilities (Option 4)
( ) with an experimentally validated computer simulation (Option 5)

7. A total of 53 tests were conducted on nonleaking tank(s) between 24/01/94 (date) and 17/02/94 (date). A description of the pipeline configuration used in the evaluation is summarized in Attachment 3.

*Answer questions 8 and 9 if Option 1, 2, or 5 was used.*

8. The pipeline used in the evaluation was 2 in. in diameter, 270 ft long and constructed of flexline (fiberglass, steel, or other).

9. A mechanical line leak detector
(X) was
( ) was not
present in the pipeline system.

*Answer questions 10 and 11 if Option 3 or 4 was used.*

10. The evaluation was conducted on _____ (how many) pipeline systems ranging in diameter from _____ in. to _____ in., ranging in length from _____ ft to _____ ft, and constructed of _____ (specify materials).

11. A mechanical line leak detector
( ) was
( ) was not
present in the majority of the pipeline systems used in the evaluation.

12. Please specify how much time elapsed between the delivery of product and the start of the data collection:
(X) 0 to 6 h (time after completition of circulation and start of test)
( ) 6 to 12 h
( ) 12 to 24 h
( ) 24 h or more

## Temperature Conditions

This system was evaluated under the range of temperature conditions specified in Table 1. The difference between the temperature of the product circulated through the pipeline for 1 h or more and the average temperature of the backfill and soil between 2 and 12 in. from the pipeline is summarized in Table 1. If Option 1, 2 or 5 was used, a more detailed summary of the product temperature conditions generated for the evaluation is presented in Attachment 4. If Option 3 or 4 was used, no artificial temperature conditions were generated.

**Table 1.** Summary of Temperature Conditions Used in the Evaluation

| Minimum Number of Conditions Required | Number of Conditions Used* | Range of $\Delta T$(°F)** |
|---|---|---|
| 1 | 2 | $\Delta T < -25$ |
| 4 | 8 | $-25 \leq \Delta T < -15$ |
| 5 | 10 | $-15 \leq \Delta T < -5$ |
| 5 | 13 | $-5 \leq \Delta T < +5$ |
| 5 | 10 | $+5 \leq \Delta T < +15$ |
| 4 | 8 | $+15 \leq \Delta T < +25$ |
| 1 | 2 | $\Delta T > 25$ |

*This column should be filled out only if Option 1, 2, or 5 was used.

**$\Delta T$ is the difference between the temperature of the product dispensed through the pipeline for over an hour prior to the conduct of a test and the average temperature of the backfill and soil surrounding the pipe.

## Data Used to Make Performance Estimates

13. The induced leak rate and the test results used to estimate the performance of this system are summarized in Attachment 5. Were any test runs removed from the data set?

(X) no
( ) yes

If yes, please specify the reason and include with Attachment 5. (If more than one test was removed, specify each reason separately.)

## Sensitivity to Trapped Vapor

14. (X) According to the vendor, this system can be used even if trapped vapor is present in the pipeline during a test.
( ) According to the vendor, this system *should not be used* if trapped vapor is present in the pipeline.

15. The sensitivity of this system to trapped vapor is indicated by the test results summarized in Table 2. These tests were conducted at pump operating pressure psi with 110 ml of vapor trapped in the line at a pressure of 0 psi. The data and test conditions are reported in Attachment 6.

**Table 2.** Summary of the Results of Trapped Vapor Tests

| Test No. | ΔT (°F) | Induced Leak Rate (gal/h @ 10 psi) | Measured Leak Rate (gal/h) |
|---|---|---|---|
| 1 | -3.12 | 2.69 | Leak Detected |
| 2 | -3.12 | 0.00 | Tight |
| 3 | -3.12 | 3.25 | Leak detected |

## Performance Characteristics of the Instrumentation

16. State below the performance characteristics of the primary measurement system used to collect the data. (Please specify the units, for example, gallons, inches.)

| | Volume | Temperature |
|---|---|---|
| Quantity Measured: | gallons per hour | degrees F |
| Resolution: | 0.01 gal/hr | 0.01 deg F |
| Precision: | 0.05 gal/hr | 0.03 deg F |
| Accuracy: | 0.1 gal/hr | 0.1 deg F |
| Minimum Detectable Quantity: | 0.01 gal | 0.02 deg F |
| Response Time: | N/A | 2 minutes |

Threshold is exceeded when the flow rate due to a leak exceeds 2.0 gal/h. (@10 psi)

## Application of the System

17. This leak detection system is intended to test pipeline systems that are associated with underground storage tank facilities, that contain petroleum or other chemical products, that are typically constructed of fiberglass or steel, and that typically measure 2 or 3 in. in diameter and 700 ft or less in length. The performance estimates are valid when:

- the system that was evaluated has not been substantially changed by subsequent modifications
- the manufacturer's instructions for using the system are followed
- the mechanical line leak detector
(X) is present in
( ) has been removed from
the pipeline (check both if appropriate)

- the waiting time between the last delivery of product to the underground storage tank and the start of data collection for the test is __0__ h
- the waiting time between the last dispensing of product through the pipeline system and the start of data collection for the test is __0__ h
- the total data collection time for the test is __≤3__ min (depending on temperature)
- the volume of the product in the pipeline is less than twice the volume of the product in the pipeline system using in the evaluation, unless separate written justification for testing larger pipeline systems is presented by the manufacturer, concurred with by the evaluator, and attached to this evaluation as Attachment 8
- please give any other limitations specified by the vendor or determined during the evaluation: __none__

***Disclaimer:*** *This test procedure only addresses the issue of the system's ability to detect leaks in pipelines. It does not test the equipment for safety hazards or assess the operational functionality, reliability or maintainability of the equipment.*

## Attachments

Attachment 1 - Description of the System Evaluated

Attachment 2 - Summary of the Performance of the System Evaluated

Attachment 3 - Summary of the Configuration of the Pipeline System(s) Used in the Evaluation

Attachment 4 - Data Sheet Summarizing Product Temperature Conditions Used in the Evaluation

Attachment 5 - Data Sheet Summarizing the Test Results and the Leak Rates Used in the Evaluation

Attachment 6 - Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Attachment 7 - Data Sheet Summarizing the Test Results Used to Check the Relationship Supplied by the Manufacturer for Combining the Signal and Noise

## Certification of Results

I certify that the pipeline leak detection system was operated according to the vendor's instructions. I also certify that the evaluation was performed according to the procedure specified by the EPA and that the results presented above are those obtained during the evaluation.

H. Kendall Wilcox, President
(name of person performing evaluation)

H. Kendall Wilcox
(signature)

March 24, 1994
(date)

(816) 795-7997
(telephone number)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

19401 E. 40 Highway
(street address)

Independence, Missouri 64055
(city, state, zip)

**Attachment 1**

# Description

## Pipeline Leak Detection System

This form provides supporting information on the operating principles of the leak detection system or on how the equipment works. This form is to be filled out by the evaluating organization with assistance from the manufacturer before the start of the evaluation.

Describe the important features of the system as indicated below. A detailed description is not required, nor is it necessary to reveal proprietary features of the system.

To minimize the time required to complete this form, the most frequently expected answers to the questions have been provided. For those answers that are dependent on site conditions, please give answers that apply in "typical" conditions. Please write in any additional information about the system that you believe is important.

Check all appropriate boxes for each question. Check more than one box per question if it applies. If 'Other' is checked, please complete the space provided to specify or briefly describe the matter. If necessary, use all the white space next to a question to complete a description.

**System Name and Version:** FE Petro STP-MLD-E

**Date:** March 24, 1994

## Applicability of the System

1. With what products can this system be used? (Check all applicable responses.)

   (X) gasoline
   (X) diesel
   (X) aviation fuel
   ( ) fuel oil #4
   ( ) fuel oil #6
   (X) solvent Per Manufacturer's Approval
   ( ) waste oil
   ( ) other (specify) _____

2. What types of pipelines can be tested? (Check all applicable responses.)

   (X) fiberglass
   (X) steel
   (X) other (specify) flexible pipeline

3. Can this leak detection system be used to test double-wall pipeline systems?

   (X) yes ( ) no

4. What is the nominal diameter of a pipeline that can be tested with this system?

(X) 1 in. or less
(X) between 1 and 3 in.
( ) between 3 and 6 in.
( ) between 6 and 10 in.
( ) other _____

5. The system can be used on pipelines pressurized to __50__ psi.

The safe maximum operating pressure for this system is __50__ psi.

6. Does the system conduct a test while a mechanical line leak detector is in place in the pipeline?

(X) yes ( ) no (system is a mechanical leak detector

## General Features of the System

7. What type of test is the system conducting? (Check all applicable responses.)

( ) 0.1 gal/h Line Tightness Test
( ) 0.2 gal/h Monthly Monitoring Test
(X) 3 gal/h Hourly Test

8. Is the system permanently installed on the pipeline?

(X) yes ( ) no

Does the system test the line automatically?

(X) yes ( ) no

If a leak is declared, what does the system do? (Check all applicable responses.)

( ) displays or prints a message (x) restricts the dispensing system
( ) triggers an alarm
( ) alerts the operator
( ) shuts down the dispensing system

9. What quantity or quantities are measured by the system? (Please list.)
Pressure (psi)

10. Does the system use a preset threshold that is automatically activated or that automatically turns on an alarm?

(X) yes (If yes, skip question 11.)
( ) no (If no, answer question 11.)

11. Does the system measure and report the quantity?
( ) yes (X) no

If so, is the output quantity converted to flow rate in gallons per hour?

( ) yes ( ) no

12. What is the specified line pressure during a test?

(X) operating pressure of line
( ) 150% of operating pressure
( ) a specific test pressure of _____ psi

## Test Protocol

13. What is the minimum waiting period required between a delivery of product to an underground storage tank and the start of the data collection for a pipeline leak detection test?

(X) no waiting period
( ) less than 15 min
( ) 15 min to 1 h
( ) 1 to 5 h
( ) 6 to 12 h
( ) 12 to 24 h
( ) greater than 24 h
( ) variable (Briefly explain.) _____

14. What is the minimum waiting period required between the last dispensing of product through the pipeline and the start of the data collection for a pipeline leak detection test?

(X) no waiting period
( ) less than 15 min
( ) 15 min to 1 h
( ) 1 to 4 h
( ) 4 to 8 h
( ) greater than 8 h
( ) variable (Briefly explain.) _____

15. What is the minimum amount of time necessary to set up equipment and complete a leak detection test? (Include setup time, waiting time and data collection time. If a multiple-test sequence is used, give the amount of time necessary to complete the first test as well as the total amount of time necessary to complete the entire sequence.)

N/A min (single test)
N/A h (multiple test)

16. Does the system compensate for those pressure or volume changes of the product in the pipeline that are due to temperature changes?

( ) yes (up to 3 cu in) (X) no

17. Is there a special test to check the pipeline for trapped vapor?

( ) yes (X) no

18. Can a test be performed with trapped vapor in the pipeline?

(X) yes ( ) no

19. If trapped vapor is found in the pipeline, is it removed before a test is performed?

( ) yes (X) no

20. Are deviations from this protocol acceptable?

( ) yes (X) no

If yes, briefly specify: _____

21. Are elements of the test procedure determined by on-site personnel?

( ) yes (X) no

If yes, which ones? (Check all applicable responses.)

( ) waiting period between filling the tank and the beginning of data collection for the test
( ) length of test
( ) determination of the presence of vapor pockets
( ) determination of "outlier" (or anomalous) data that may be discarded
( ) other (Describe briefly.) _____

## Data Acquisition

22. How are the test data acquired and recorded? (n/a, simple threshold test done mechanically.)

( ) manually (x) not applicable
( ) by strip chart
( ) by computer
( ) by microprocessor

23. Certain calculations are necessary to reduce and analyze the data. How are these calculations done? n/a Simple threshold test done mechanically.

( ) manual calculations by the operator on site (x) not applicable
( ) interactive computer program used by the operator
( ) automatically done with a computer program
( ) automatically done with a microprocessor

## Detection Criterion

24. What threshold is used to determine whether the pipeline is leaking?

2.0 gal/hr (in the units used by the measurement system)
2.0 gal/hr (in gal/h)

25. Is a multiple-test sequence used to determine whether the pipeline is leaking?

( ) yes (If yes, answer the three questions below)
(X) no (If no, skip the three questions below)

How many tests are conducted? _____
How many tests are required before a leak can be declared? _____
What is the time between tests? _____
(Enter 0 if the tests are conducted one after the other)

## Calibration

26. How frequently are the sensor systems calibrated?

( ) never
( ) before each test
( ) weekly
( ) monthly
( ) semi-annually
(X) yearly or less frequently, recommended performance check

## Attachment 2
## Summary of Performance Estimates

### Pipeline Leak Detection System
### Used as an
### *Hourly Monitoring Test*

Complete this page if the pipeline leak detection system has been evaluated as an hourly test. Please complete the first table. Completion of the last three tables is optional. (The last three tables present the performance of the system for different combinations of thresholds, probabilities of false alarm, and probabilities of detection. They are useful for comparing the performance of this system to that of other systems.)

Performance of the Pipeline Leak Detection System as Evaluated

| Description | Leak Rate (gal/h) | $P_D$ | $P_{FA}$ | Threshold (gal/h) |
|---|---|---|---|---|
| Evaluated System | 3 | 1.00 | 0 | 2.0 |
| EPA Standard | 3 | 0.95 | 0.05 | N/A |

Probability of False Alarm as a Function of Threshold

| Threshold (gal/h) | Probability of False Alarm |
|---|---|
| Not determined | 0.10 |
| | 0.075 |
| | 0.05 |
| | 0.05 |

Probability of Detection as a Function of Threshold for a Leak Rate of 3.0 gal/h

| Threshold (gal/h) | Probability of Detection |
|---|---|
| Not determined | 0.95 |
| | 0.90 |
| | 0.80 |
| | 0.50 |

Smallest Leak Rate that Can be Detected with the Specified Probability of Detection and Probability of False Alarm

| Leak Rate (gal/h) | Probability of Detection | Probability of False Alarm |
|---|---|---|
| Not determined | 0.95 | 0.10 |
| | 0.95 | 0.075 |
| | 0.95 | 0.05 |
| | 0.90 | 0.05 |
| | 0.80 | 0.05 |
| | 0.50 | 0.05 |

**Attachment 3**

# Summary of the Configuration of the Pipeline System(s) Used in the Evaluation

## Pipeline Leak Detection System
***Options 1, 2, and 5***

| Specialized Test Facility, Operational Storage Tank System, or Computer Simulation | |
|---|---|
| Inside diameter of pipeline (in.) | 2 in |
| Length of pipeline (tank to dispenser) (ft) | 270 ft |
| Volume of product in line during testing (gal) | 24.8 |
| Type of material (fiberglass, steel, other[1]) | flexline |
| Type of product in tank and pipeline (gasoline, diesel, other[2]) | gasoline |
| Was a mechanical line leak detector present? (yes or no) | yes |
| Was trapped vapor present? (yes or no) | in 3 of 53 tests |
| Bulk Modulus (B) (psi) | 1280 |
| $B/V_o$ (psi/ml) | -0.0134 |
| Storage tank capacity (gal) | 560 gal |

[1]Specify type of construction material.
[2]Specify type of product for each tank.

**Attachment 4**

**Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation**

**Pipeline Leak Detection System**

**Options 1 and 5**

| Test No. (Based on Temperature Condition) | Date Test Began | Nominal Product Temperature Before Circulation Was Started | Time Circulation Started | Time Circulation Ended | Duration of Circulation | Time of Temperature Measurements | Ttb | T1 | T2 | T3 | Tg | Ttb-Tg | Temperature Test Matrix Category |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (D-M-Y) | (deg F) | (military) | (deg F) | (h-min) | (military) | (deg F) | (deg F) | (deg F) | (deg F) | (deg F) | (deg F) | (Table 5) |
| 1 | 24-01-94 | 61.00 | 1046 | 1146 | 1 hr | 1046 | 61.00 | 36.51 | 35.74 | 35.65 | 35.77 | +25.23 | >+25 |
| 2 | 24-01-94 | 61.00 | 1046 | 1146 | 1 hr | 1046 | 61.00 | 36.51 | 35.74 | 35.65 | 35.77 | +25.23 | >+25 |
| 3 | 24-01-94 | 59.11 | 1201 | 1301 | 1 hr | 1201 | 59.11 | 37.83 | 36.46 | 35.82 | 36.19 | +22.92 | +15 to +25 |
| 4 | 24-01-94 | 59.11 | 1201 | 1301 | 1 hr | 1201 | 59.11 | 37.83 | 36.46 | 35.82 | 36.19 | +22.92 | +15 to +25 |
| 5 | 24-01-94 | 59.11 | 1201 | 1301 | 1 hr | 1201 | 59.11 | 37.83 | 36.46 | 35.82 | 36.19 | +22.92 | +15 to +25 |
| 6 | 24-01-94 | 56.28 | 1319 | 1419 | 1 hr | 1319 | 56.28 | 38.19 | 36.85 | 35.95 | 36.40 | +19.88 | +15 to +25 |
| 7 | 24-01-94 | 56.28 | 1319 | 1419 | 1 hr | 1319 | 56.28 | 38.19 | 36.85 | 35.95 | 36.40 | ^ +19.88 | +15 to +25 |
| 8 | 24-01-94 | 53.32 | 1440 | 1540 | 1 hr | 1440 | 53.32 | 38.28 | 37.26 | 35.69 | 36.32 | +17.00 | +15 to +25 |
| 9 | 24-01-94 | 53.32 | 1440 | 1540 | 1 hr | 1440 | 53.32 | 38.28 | 37.26 | 35.69 | 36.32 | +17.00 | +15 to +25 |
| 10 | 24-01-94 | 53.32 | 1440 | 1540 | 1 hr | 1440 | 53.32 | 38.28 | 37.26 | 35.69 | 36.32 | +17.00 | +15 to +25 |
| 11 | 24-01-94 | 49.16 | 1610 | 1710 | 1 hr | 1610 | 49.16 | 36.57 | 37.11 | 36.33 | 36.75 | +12.41 | +5 to +15 |
| 12 | 24-01-94 | 49.16 | 1610 | 1710 | 1 hr | 1610 | 49.16 | 36.57 | 37.11 | 36.33 | 36.75 | +12.41 | +5 to +15 |
| 13 | 24-01-94 | 49.16 | 1610 | 1710 | 1 hr | 1610 | 49.16 | 36.57 | 37.11 | 36.33 | 36.75 | +12.41 | +5 to +15 |
| 14 | 24-01-94 | 47.21 | 1724 | 1824 | 1 hr | 1724 | 47.21 | 38.35 | 37.09 | 35.92 | 36.45 | +10.76 | +5 to +15 |
| 15 | 24-01-94 | 47.21 | 1724 | 1824 | 1 hr | 1724 | 47.21 | 38.35 | 37.09 | 35.92 | 36.45 | +10.76 | +5 to +15 |
| 16 | 25-01-94 | 11.02 | 0635 | 0735 | 1 hr | 0635 | 11.02 | 37.07 | 36.86 | 36.43 | 36.60 | -25.58 | >-25 |
| 17 | 25-01-94 | 11.02 | 0635 | 0735 | 1 hr | 0635 | 11.02 | 37.07 | 36.86 | 36.43 | 36.60 | -25.58 | >-25 |
| 18 | 25-01-94 | 14.08 | 0854 | 0954 | 1 hr | 0854 | 14.08 | 36.32 | 36.43 | 36.14 | 36.22 | -22.14 | -15 to -25 |
| 19 | 25-01-94 | 14.08 | 0854 | 0954 | 1 hr | 0854 | 14.08 | 36.32 | 36.43 | 36.14 | 36.22 | -22.14 | -15 to -25 |
| 20 | 25-01-94 | 14.08 | 0854 | 0954 | 1 hr | 0854 | 14.08 | 36.32 | 36.43 | 36.14 | 36.22 | -22.14 | -15 to -25 |
| 21 | 25-01-94 | 19.43 | 1412 | 1512 | 1 hr | 1412 | 15.43 | 36.82 | 36.85 | 36.61 | 36.69 | -17.26 | -15 to -25 |
| 22 | 25-01-94 | 19.43 | 1412 | 1512 | 1 hr | 1412 | 15.43 | 36.82 | 36.85 | 36.61 | 36.69 | -17.26 | -15 to -25 |
| 23 | 26-01-94 | 21.90 | 0904 | 1004 | 1 hr | 0904 | 21.90 | 37.34 | 38.56 | 37.03 | 37.40 | -15.50 | -15 to -25 |
| 24 | 26-01-94 | 21.90 | 0904 | 1004 | 1 hr | 0904 | 21.90 | 37.34 | 38.56 | 37.03 | 37.40 | -15.50 | -15 to -25 |
| 25 | 26-01-94 | 21.90 | 0904 | 1004 | 1 hr | 0904 | 21.90 | 37.34 | 38.56 | 37.03 | 37.40 | -15.50 | -15 to -25 |
| 26 | 26-01-94 | 23.95 | 1058 | 1158 | 1hr | 1058 | 23.95 | 37.08 | 38.33 | 37.00 | 37.30 | -13.35 | -5 to -15 |

**Attachment 4 (continued)**
**Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation**
**Pipeline Leak Detection System**
**Options 1 and 6**

| Test No. (Based on Temperature Condition) | Date Test Began | Nominal Product Temperature Before Circulation Was Started | Time Circulation Started | Time Circulation Ended | Duration of Circulation | Time of Temperature Measurements | Tlb | T1 | T2 | T3 | Tg | Tlb-Tg | Temperature Test Matrix Category |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (D-M-Y) | (deg F) | (military) | (deg F) | (h-min) | (military) | (deg F) | (deg F) | (deg F) | (deg F) | (deg F) | (deg F) | (Table 5) |
| 27 | 26-01-94 | 23.95 | 1058 | 1158 | 1 hr | 1058 | 23.95 | 37.08 | 38.33 | 37.00 | 37.30 | -13.35 | -5 to -15 |
| 28 | 26-01-94 | 23.95 | 1058 | 1158 | 1 hr | 1058 | 23.95 | 37.08 | 38.33 | 37.00 | 37.30 | -13.35 | -5 to -15 |
| 29 | 26-01-94 | 26.05 | 1405 | 1505 | 1 hr | 1405 | 26.05 | 37.39 | 38.46 | 37.03 | 37.39 | -11.34 | -5 to -15 |
| 30 | 26-01-94 | 26.05 | 1405 | 1505 | 1 hr | 1405 | 26.05 | 37.39 | 38.46 | 37.03 | 37.39 | -11.34 | -5 to -15 |
| 31 | 26-01-94 | 28.25 | 1616 | 1716 | 1 hr | 1616 | 28.25 | 37.70 | 38.41 | 37.23 | 37.54 | -9.29 | -5 to -15 |
| 32 | 26-01-94 | 28.25 | 1616 | 1716 | 1 hr | 1616 | 28.25 | 37.70 | 38.41 | 37.23 | 37.54 | -9.29 | -5 to -15 |
| 33 | 27-01-94 | 36.01 | 0750 | 0850 | 1 hr | 0750 | 36.01 | 37.83 | 37.98 | 37.49 | 37.63 | -1.62 | -5 to +5 |
| 34 | 27-01-94 | 36.01 | 0750 | 0850 | 1 hr | 0750 | 36.01 | 37.83 | 37.98 | 37.49 | 37.63 | -1.62 | -5 to +5 |
| 35 | 27-01-94 | 36.01 | 0750 | 0850 | 1 hr | 0750 | 36.01 | 37.83 | 37.98 | 37.49 | 37.63 | -1.62 | -5 to +5 |
| 36 | 27-01-94 | 33.89 | 1038 | 1138 | 1 hr | 1038 | 33.89 | 37.95 | 37.46 | 37.98 | 37.86 | -3.97 | -5 to +5 |
| 37 | 27-01-94 | 33.89 | 1038 | 1138 | 1 hr | 1038 | 33.89 | 37.95 | 37.46 | 37.98 | 37.86 | -3.97 | -5 to +5 |
| 38 | 27-01-94 | 30.91 | 1159 | 1259 | 1 hr | 1159 | 30.91 | 38.12 | 37.72 | 37.33 | 37.51 | -6.60 | -5 to -15 |
| 39 | 27-01-94 | 30.91 | 1159 | 1259 | 1 hr | 1159 | 30.91 | 38.12 | 37.72 | 37.33 | 37.51 | -6.60 | -5 to -15 |
| 40 | 27-01-94 | 30.91 | 1159 | 1259 | 1 hr | 1159 | 30.91 | 38.12 | 37.72 | 37.33 | 37.51 | -6.60 | -5 to -15 |
| 41 | 17-02-94 | 47.42 | 0234 | 0334 | 1 hr | 0234 | 47.42 | 38.13 | 38.73 | 38.18 | 38.30 | 9.12 | +5 to +15 |
| 42 | 17-02-94 | 47.42 | 0234 | 0334 | 1 hr | 0234 | 47.42 | 38.13 | 38.73 | 38.18 | 38.30 | 9.12 | +5 to +15 |
| 43 | 17-02-94 | 45.03 | 0348 | 0448 | 1 hr | 0348 | 45.03 | 38.59 | 38.84 | 38.02 | 38.27 | 6.76 | +5 to +15 |
| 44 | 17-02-94 | 45.03 | 0348 | 0448 | 1 hr | 0348 | 45.03 | 38.59 | 38.84 | 38.02 | 38.27 | 6.76 | +5 to +15 |
| 45 | 17-02-94 | 45.03 | 0348 | 0448 | 1 hr | 0348 | 45.03 | 38.59 | 38.84 | 38.02 | 38.27 | 6.76 | +5 to +15 |
| 46 | 17-02-94 | 42.39 | 0504 | 0604 | 1 hr | 0504 | 42.39 | 39.15 | 38.90 | 38.26 | 38.51 | 3.88 | -5 to +5 |
| 47 | 17-02-94 | 42.39 | 0504 | 0604 | 1 hr | 0504 | 42.39 | 39.15 | 38.90 | 38.26 | 38.51 | 3.88 | -5 to +5 |
| 48 | 17-02-94 | 40.26 | 0615 | 0715 | 1 hr | 0615 | 40.26 | 39.04 | 38.86 | 38.25 | 38.47 | 1.79 | -5 to +5 |
| 49 | 17-02-94 | 40.26 | 0615 | 0715 | 1 hr | 0615 | 40.26 | 39.04 | 38.86 | 38.25 | 38.47 | 1.79 | -5 to +5 |
| 50 | 17-02-94 | 40.26 | 0615 | 0715 | 1 hr | 0615 | 40.26 | 39.04 | 38.86 | 38.25 | 38.47 | 1.79 | -5 to +5 |

**Attachment 5**
**Data Sheet Summarizing the Test Results and the Leak Rates Used in the Evaluation**
**Options 1 and 5**
**Hourly Monitoring**

| Test No. (Based on Temperature | Date Test Began | Induced Leak Rate @ 10 psi | Time between End of Circulation and Start of Data Collection for Test | Time Data Collection Began | Time Data Collection Ended | Test Result | Was Threshold Exceeded? |
|---|---|---|---|---|---|---|---|
| | (D-M-Y) | (gal/hr) | (h-min) | (military) | (military) | (leak or tight) | (yes or no) |
| 1 | 24-01-94 | 0 | 1 min | 1147 | 1150 | tight | no |
| 2 | 24-01-94 | 2.69 | 4 min | 1150 | 1154 | leak | yes |
| 3 | 24-01-94 | 0 | 1 min | 1302 | 1305 | tight | no |
| 4 | 24-01-94 | 2.69 | 4 min | 1305 | 1309 | leak | yes |
| 5 | 24-01-94 | 0 | 9 min | 1310 | 1313 | tight | no |
| 6 | 24-01-94 | 0 | 1 min | 1420 | 1423 | tight | no |
| 7 | 24-01-94 | 2.69 | 4 min | 1423 | 1427 | leak | yes |
| 8 | 24-01-94 | 2.69 | 1 min | 1541 | 1545 | leak | yes |
| 9 | 24-01-94 | 0 | 4 min | 1546 | 1549 | tight | no |
| 10 | 24-01-94 | 2.69 | 9 min | 1549 | 1553 | leak | yes |
| 11 | 24-01-94 | 0 | 1 min | 1711 | 1714 | tight | no |
| 12 | 24-01-94 | 2.69 | 4 min | 1714 | 1718 | leak | yes |
| 13 | 24-01-94 | 0 | 9 min | 1719 | 1722 | tight | no |
| 14 | 24-01-94 | 2.69 | 1 min | 1825 | 1829 | leak | yes |
| 15 | 24-01-94 | 0 | 6 min | 1830 | 1833 | tight | no |
| 16 | 25-01-94 | 2.69 | 10 min | 0745 | 0749 | leak | yes |
| 17 | 25-01-94 | 0 | 15 min | 0750 | 0752 | tight | no |
| 18 | 25-01-94 | 2.69 | 1 min | 0955 | 0959 | leak | yes |
| 19 | 25-01-94 | 0 | 6 min | 1000 | 1003 | tight | no |
| 20 | 25-01-94 | 2.69 | 9 min | 1003 | 1007 | leak | yes |
| 21 | 25-01-94 | 0 | 2 min | 1514 | 1516 | tight | no |
| 22 | 25-01-94 | 2.69 | 6 min | 1518 | 1522 | leak | yes |
| 23 | 26-01-94 | 0 | 1 min | 1005 | 1008 | tight | no |
| 24 | 26-01-94 | 2.69 | 5 min | 1009 | 1013 | leak | yes |
| 25 | 26-01-94 | 0 | 9 min | 1013 | 1015 | tight | no |
| 26 | 26-01-94 | 2.69 | 1 min | 1159 | 1203 | leak | yes |
| 27 | 26-01-94 | 0 | 5 min | 1203 | 1206 | tight | no |
| 28 | 26-01-94 | 2.69 | 9 min | 1207 | 1211 | leak | yes |
| 29 | 26-01-94 | 0 | 1 min | 1506 | 1509 | tight | no |
| 30 | 26-01-94 | 2.69 | 5 min | 1510 | 1514 | leak | yes |
| 31 | 26-01-94 | 2.69 | 1 min | 1717 | 1721 | leak | yes |
| 32 | 26-01-94 | 0 | 6 min | 1722 | 1725 | tight | no |
| 33 | 27-01-94 | 2.69 | 1 min | 0851 | 0856 | leak | yes |
| 34 | 27-01-94 | 0 | 6 min | 0856 | 0859 | tight | no |
| 35 | 27-01-94 | 2.69 | 10 min | 0900 | 0905 | leak | yes |
| 36 | 27-01-94 | 0 | 1 min | 1139 | 1142 | tight | no |
| 37 | 27-01-94 | 2.69 | 4 min | 1142 | 1146 | leak | yes |
| 38 | 27-01-94 | 0 | 1 min | 1300 | 1302 | tight | no |
| 39 | 27-01-94 | 2.69 | 4 min | 1303 | 1307 | leak | yes |
| 40 | 27-01-94 | 0 | ^ 9 min | 1308 | 1311 | tight | no |
| 41 | 17-02-94 | 0 | 1 min | 0335 | 0337 | tight | no |
| 42 | 17-02-94 | 2.69 | 3 min | 0337 | 0341 | leak | yes |
| 43 | 17-02-94 | 2.69 | 1 min | 0449 | 0453 | leak | yes |
| 44 | 17-02-94 | 0 | 6 min | 0454 | 0456 | tight | no |
| 45 | 17-02-94 | 2.69 | 8 min | 0456 | 0500 | leak | yes |
| 46 | 17-02-94 | 2.69 | 1 min | 0605 | 0609 | leak | yes |
| 47 | 17-02-94 | 0 | 6 min | 0610 | 0612 | tight | no |
| 48 | 17-02-94 | 0 | 1 min | 0716 | 0718 | tight | no |
| 49 | 17-02-94 | 2.69 | 3 min | 0718 | 0722 | leak | yes |
| 50 | 17-02-94 | 0 | 8 min | 0723 | 0725 | tight | no |

**Attachment 6**
**Data Sheet Summarizing the Test Results and the Trapped Vapor Tests**
**Pipeline Leak Detection System**
**Options 1 and 5**
**Hourly Monitoring**
**Summary of Temperature Conditions**

| Test No. | Date Test Began | Nominal Product Temperature Before Circulation Was Started | Time Circulation Started | Time Circulation Ended | Duration of Circulation | Time of Temperature Measurements | Ttb | T1 | T2 | T3 | Tg | Ttb-Tg | Temperature Test Matrix Category |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | (D-M-Y) | (deg F) | (military | (military) | (h-min) | (military) | (deg F) | (deg F) | (deg F) | (deg F) | (deg F) | (deg F) | (Table 5) |
| V1 | 27-01-94 | 34.98 | 0910 | 1010 | ^ 1 hr | 0910 | 34.98 | 37.64 | 37.89 | 38.25 | 38.10 | -3.12 | -5 t.+5 |
| V2 | 27-01-94 | 34.98 | 0910 | 1010 | 1 hr | 0910 | 34.98 | 36.64 | 37.89 | 38.25 | 38.10 | -3.12 | -5 to +5 |
| V3 | 27-01-94 | 34.98 | 0910 | 1010 | 1 hr | 0910 | 34.98 | 36.64 | 37.89 | 38.25 | 38.10 | -3.12 | -5 to +5 |

Summary of Leak Rates

| Test No. | Date Test Began | Pipeline Pressure | Induced Leak Rate @ 10 psi | Time between End of Circulation and Start of Data Collection for Test | Time Data Collection Began | Time Data Collection Ended | Measured Test Result | Was Threshold Exceeded? |
|---|---|---|---|---|---|---|---|---|
| | (D-M-Y) | (psi) | (gal/h) | (h-mfn) | (military) | (military) | (gal/h) | (yes or no) |
| V1 | 27-01-94 | 30 | 2.69 | 1 min | 1011 | 1016 | leak | yes |
| V2 | 27-01-94 | 30 | 0 | 7 min | 1017 | 1720 | tight | no |
| V3 | 27-01-94 | 30 | 3.25 | 11 min | 1021 | 1026 | leak | yes |

**Attachment 7**

# Data Sheet Summarizing the Test Results Used to Check the Relationship Supplied by the Manufacturer for Combining the Signal and Noise

## Pipeline Leak Detection System
***Options 1 and 5***

NOT APPLICABLE TO THIS EVALUATION

| First Check | | |
|---|---|---|
| Test No. | Actual Leak Rate* (gal/h) | Measured Leak Rate (gal/h) |
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |

* Recommended leak rates for monthly monitoring tests and line tightness tests: 0.0, 0.05, 0.10, 0.20, 0.30 and 0.40 gal/h. Recommended leak rates for hourly tests: 0.0, 2.0, 2.5, 3.0, 3.5, and 4.0 gal/h.

| Second Check | | |
|---|---|---|
| Test No. | Actual Leak Rate* (gal/h) | Measured Leak Rate (gal/h) |
| A | | |
| B | | |
| C | | |
| A + B* | | |

* A + B is the summation of the results of Tests A and B using the manufacturer's relationship for combining the signal and the noise.