



# **Evaluation of the FE Petro STP-MLD Pipeline Leak Detection System**

**Volume I. Final Report**

**PREPARED FOR  
FE Petro, Inc.**

**July 1, 1992**



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**FE Petro, Inc.**  
**P.O. Box 139**  
**McFarland, WI 53558**

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## PREFACE

The evaluation described in this report was conducted for FE Petro, Inc. of McFarland, Wisconsin, by Ken Wilcox Associates, Inc. The report describes the evaluation and performance of the FE Petro STP-MLD Mechanical Line Leak Detector used as an hourly monitoring device to check for leaks in underground pressurized piping. The test results are presented in Volume I and the test data is presented in Volume II.

The testing was conducted using the U.S. Environmental Protection Agency's protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Pipeline Leak Detection Systems," EPA/530/UST-90/010, September 1990. The test results are reported on the standard forms provided by the EPA. The testing was conducted at the Leak Detection Test Center in Kansas City, Missouri, by Ken Wilcox Associates, Inc. The report was prepared by Dr. Ken Wilcox.

Technical questions should be directed to Mr. Charles Franklin, FE Petro, Inc. at (608) 838-8786.

H. Kendall Wilcox, President  
KEN WILCOX ASSOCIATES, INC.



August 6, 1992

## **EXECUTIVE SUMMARY**

The FE Petro Model STP-MLD Mechanical Line Leak Detector is used as an automatic device to test for leaks in pressurized underground piping systems. It has been tested according to the U.S. Environmental Protection Agency (EPA) protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Pipeline Leak Detection Systems" as an hourly monitoring device. The results show that the STP-MLD exceeds the performance requirements of the EPA for hourly line leak detection systems. It is capable of detecting leak rates of 3 gal/hr with a probability of detection of 100% and a probability of false alarm of 0%. Under stable conditions, the STP-MLD may detect leaks as small as 2 gal/hr.

The testing was conducted on a 3-in diameter by 176 ft long fiberglass line (64.6 gal) which means that the STP-MLD is approved for lines up to 129.2 gal capacity.

# TEST REPORT FOR THE EVALUATION OF THE FE PETRO, INC. STP-MLD MECHANICAL LINE LEAK DETECTOR

## Introduction

This section presents the evaluation of the FE Petro STP-MLD Line Leak Detector. 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 Appendix 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." The testing described in this report was conducted using the hourly line leak detector methods described in the EPA protocol.

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.

Option 1 of the evaluation protocol was selected for testing of the STP-MLD. 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.

## Description of the FE Petro STP-MLD Leak Detector

The STP-MLD Leak Detector is a mechanical line leak detector. It uses a piston/spring mechanism to monitor the line pressure when the pump is off, control the position of the leak

detection mechanism according to the line pressure, and supply a limited amount of liquid to the line should product volume be lost for any reason. If the STP-MLD has sensed a leak (or is in the leak testing mode) it will be closed, restricting flow to the dispenser.

### **Description of the Test Site and Operating Procedures**

Testing was conducted on a 176 ft 3-in diameter fiberglass line. A 560 gal 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. Temperatures were monitored using RTD's which were calibrated against an NBS traceable quartz 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 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 was installed directly on the pump discharge, the usual position for it to operate in.
- 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 range of approximately 30 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 to the leak detect mode. This process took approximately one minute.

- 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 (usually 28 to 30 psi) a non-leaking line was indicated.
- 8) Since the test times were very 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 is found to be leaking (a correct conclusion). Second, a non-leaking line is found to be tight (a correction 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 have been reported using the Performance Evaluation forms provided in the EPA protocol which certify the test results. These have been reproduced in Appendix A. The data, test conditions, and other technical information is summarized in several attachments to the Performance Evaluation, which are provided in Appendix B. Table 1 summarizes the test requirements for various temperature conditions. Table 2 summarizes the testing which was conducted for the evaluation arranged from lowest temperature to highest. An effort was made to maintain the flow at 3.0 gal/hr for each test run, but due to the difficulty in maintaining uniform flow through an orifice under operating conditions, some of the rates vary slightly.

A total of 55 tests were conducted using the EPA evaluation protocol. These were divided into 26 leak tests, 26 no-leak tests, and 3 vapor tests. No valid 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 is very short for the STP-MLD (less than 5 minutes were required) up to three tests could be conducted for each temperature condition as discussed in Section 5.2 of the protocol.

**Appendix A**

**EPA Forms for the**

**FE Petro STP-MLD Pipeline Leak Detector**



**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.

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**System Evaluated**

System Name: STP-MLD

Version of System: \_\_\_\_\_

Manufacturer Name: FE Petro, Inc.

4423 Triangle St.  
(street address)

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

(608) 838-8786  
(telephone number)

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**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 %.

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## Criterion for Declaring a Leak

3. This system  
 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  
 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 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
- 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 55 tests were conducted on nonleaking tank(s) between 6/1/92 (date) and 6/10/92 (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 3 in. in diameter, 176 ft long and constructed of fiberglass (fiberglass, steel, or other).
9. A mechanical line leak detector  
 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:  
 0 to 6 h (time after completion 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 <sup>1</sup> | Range of $\Delta T(^{\circ}F)$ <sup>2</sup> |
|---------------------------------------|--|---|
| 1                                     | 3                                      | $\Delta T < -25$                            |
| 4                                     | 8                                      | $-25 \leq \Delta T < -15$                   |
| 5                                     | 10                                     | $-15 \leq \Delta T < -5$                    |
| 5                                     | 10                                     | $-5 \leq \Delta T < +5$                     |
| 5                                     | 10                                     | $+5 \leq \Delta T < +15$                    |
| 4                                     | 8                                      | $+15 \leq \Delta T < +25$                   |
| 1                                     | 3                                      | $\Delta T > 25$                             |

<sup>1</sup>This column should be filled out only if Option 1, 2, or 5 was used.

<sup>2</sup> $\Delta T$  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?

- 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 28 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. | $\Delta T$<br>(°F) | Induced Leak Rate<br>(gal/h @ 10 psi) | Measured Leak Rate<br>(gal/h) |
|----------|--------------------|---------------------------------------|-------------------------------|
| 1        | -8.91              | 0                                     | Tight                         |
| 2        | -8.91              | 3.25                                  | Leak                          |
| 3        | -2.15              | 2.75                                  | Leak                          |

## 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.)

Quantity Measured: meters flow into line at approx. 2 gpm  
 Resolution: system not quantitative  
 Precision: system not quantitative  
 Accuracy: system not quantitative  
 Minimum Detectable Quantity: approximately 2 gph  
 Response Time: less than 30 seconds  
 Threshold is exceeded when the flow rate due to a leak exceeds 2 gal/h.

## 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 150 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  less than 0.5  min
- 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: \_\_\_\_\_

*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)

July 1, 1992  
(date)

(816) 229-0860  
(telephone number)

Ken Wilcox Associates, Inc.  
(organization performing evaluation)

1200 S. Outer Road, Suite 221  
(street address)

Blue Springs, Missouri 64015  
(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:** STP-MLD

**Date:** July 1, 1992

#### Applicability of the System

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

gasoline

diesel

aviation fuel

fuel oil #4

fuel oil #6

solvent

waste oil

other (specify) Contact manufacturer for other hydrocarbon applications.

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

fiberglass

steel

other (specify) Contact manufacturer for other applications.

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

yes

no

4. What is the nominal diameter of a pipeline that can be tested with this system?
- 1 in. or less  
 between 1 and 3 in.  
 between 3 and 6 in. Contact manufacturer for application to lines greater than 3 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 150 psi.
6. Does the system conduct a test while a mechanical line leak detector is in place in the pipeline?
- yes                       no

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**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  
 3 gal/h Hourly Test
8. Is the system permanently installed on the pipeline?
- yes                       no
- Does the system test the line automatically?
- yes                       no
- If a leak is declared, what does the system do? (Check all applicable responses.)
- displays or prints a message  
 triggers an alarm  
 alerts the operator  
 shuts down the dispensing system  
 other restricts fuel flow to dispenser
9. What quantity or quantities are measured by the system? (Please list.)  
3 gal/hr or greater product loss
- 
10. Does the system use a preset threshold that is automatically activated or that automatically turns on an alarm?
- yes (If yes, skip question 11.)  
 no (If no, answer question 11.)
11. Does the system measure and report the quantity?
- yes                       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?

- 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?

- 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?

- 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.)

<30 sec (single test) STP-MLD is permanently installed in the system  
       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)  no

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

yes  no



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

yes                       no

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

yes                       no

20. Are deviations from this protocol acceptable?

yes                       no

If yes, briefly specify: \_\_\_\_\_

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

yes                       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?

manually

by strip chart                      N/A

by computer

by microprocessor

23. Certain calculations are necessary to reduce and analyze the data. How are these calculations done?

manual calculations by the operator on site

interactive computer program used by the operator                      N/A

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?

          gal/h           (in the units used by the measurement system)  
          2 gal/h           (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)  
 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.)

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### **Calibration**

26. How frequently are the sensor systems calibrated?

- never  
 before each test  
 weekly  
 monthly  
 semi-annually  
 yearly or less frequently

**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 <sub>D</sub> | P <sub>FA</sub> | Threshold (gal/h) |
|------------------|-------------------|----------------|-----------------|-------------------|
| Evaluated System | 3                 | 100            | 0               | 2                 |
| 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.)  | 3 in             |
| Length of pipeline (tank to dispenser) (ft)  | 176 ft           |
| Volume of product in line during testing (gal)                                     | 64.57 gal        |
| Type of material (fiberglass, steel, other <sup>1</sup> )                          | fiberglass       |
| Type of product in tank and pipeline (gasoline, diesel, other <sup>2</sup> )       | gasoline         |
| Was a mechanical line leak detector present? (yes or no)                           | yes              |
| Was trapped vapor present? (yes or no)   | in 3 of 55 tests |
| Bulk Modulus (B) (psi)   | 33,087           |
| B/V <sub>o</sub> (psi/ml)  | -0.295           |
| Storage tank capacity (gal)  | 560 gal          |

<sup>1</sup>Specify type of construction material.

<sup>2</sup>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.<br>(Based on<br>Temperature<br>Condition) | Date<br>Test<br>Began<br>(D-M-Y) | Nominal<br>Product<br>Temperature<br>Before<br>Circulation<br>Was Started<br>(deg F) | Time<br>Circulation<br>Started<br>(military) | Time<br>Circulation<br>Ended<br>(deg F) | Duration of<br>Circulation<br>(h-min) | Time of<br>Temperature<br>Measurements<br>(military) | T <sub>tb</sub><br>(deg F) | T <sub>1</sub><br>(deg F) | T <sub>2</sub><br>(deg F) | T <sub>3</sub><br>(deg F) | T <sub>g</sub><br>(deg F) | T <sub>lb-Tg</sub><br>(deg F) | Temperature<br>Matrix<br>Category<br>(Table 5) |
|--|----------------------------------|--|--|---|---------------------------------------|--|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|-------------------------------|--|
| 1  | 1-6-92                           | 37.98  | 1224   | 1324                                    | 1 hr                                  | 1224   | 37.98                      | 60.52                     | 61.39                     | 64.10                     | 63.10                     | -25.12                        | <-25   |
| 2  | 1-6-92                           | 37.98  | 1224   | 1324                                    | 1 hr                                  | 1224   | 37.98                      | 60.52                     | 61.39                     | 64.10                     | 63.10                     | -25.12                        | <-25   |
| 3  | 1-6-92                           | 37.98  | 1224   | 1324                                    | 1 hr                                  | 1224   | 37.98                      | 60.52                     | 61.39                     | 64.10                     | 63.10                     | -25.12                        | <-25   |
| 4  | 2-6-92                           | 69.33  | 0802   | 0913                                    | 1hr&11min                             | 0802   | 69.33                      | 63.48                     | 63.43                     | 64.25                     | 63.98                     | 5.35                          | +5 to +15                                      |
| 5  | 2-6-92                           | 69.33  | 0802   | 0913                                    | 1hr&11min                             | 0802   | 69.33                      | 63.48                     | 63.43                     | 64.25                     | 63.98                     | 5.35                          | +5 to +15                                      |
| 6  | 2-6-92                           | 69.33  | 0802   | 0913                                    | 1hr&11min                             | 0802   | 69.33                      | 63.48                     | 63.43                     | 64.25                     | 63.98                     | 5.35                          | +5 to +15                                      |
| 7  | 2-6-92                           | 73.49  | 0845   | 1045                                    | 1hr                                   | 0845   | 73.49                      | 64.25                     | 63.80                     | 64.30                     | 64.19                     | 9.30                          | +5 to +15                                      |
| 8  | 2-6-92                           | 73.49  | 0845   | 1045                                    | 1hr                                   | 0845   | 73.49                      | 64.25                     | 63.80                     | 64.30                     | 64.19                     | 9.30                          | +5 to +15                                      |
| 9  | 2-6-92                           | 73.49  | 0845   | 1045                                    | 1hr                                   | 0845   | 73.49                      | 64.25                     | 63.80                     | 64.30                     | 64.19                     | 9.30                          | +5 to +15                                      |
| 10   | 2-6-92                           | 90.76  | 1236   | 1336                                    | 1hr                                   | 1236   | 90.76                      | 85.39                     | 64.49                     | 64.44                     | 64.56                     | 26.20                         | >+25   |
| 11   | 2-6-92                           | 90.76  | 1236   | 1336                                    | 1hr                                   | 1236   | 90.76                      | 85.39                     | 64.49                     | 64.44                     | 64.56                     | 26.20                         | >+25   |
| 12   | 2-6-92                           | 90.76  | 1236   | 1336                                    | 1hr                                   | 1236   | 90.76                      | 85.39                     | 64.49                     | 64.44                     | 64.56                     | 26.20                         | >+25   |
| 13   | 2-6-92                           | 85.95  | 1343   | 1446                                    | 1hr&3min                              | 1343   | 85.95                      | 66.82                     | 65.32                     | 64.46                     | 64.91                     | 21.04                         | +15 to +25                                     |
| 14   | 2-6-92                           | 85.95  | 1343   | 1446                                    | 1hr&3min                              | 1343   | 85.95                      | 66.82                     | 65.32                     | 64.46                     | 64.91                     | 21.04                         | +15 to +25                                     |
| 15   | 2-6-92                           | 85.95  | 1343   | 1446                                    | 1hr&3min                              | 1343   | 85.95                      | 66.82                     | 65.32                     | 64.46                     | 64.91                     | 21.04                         | +15 to +25                                     |
| 16   | 2-6-92                           | 88.27  | 1451   | 1551                                    | 1hr                                   | 1451   | 88.27                      | 67.69                     | 66.05                     | 64.50                     | 65.20                     | 23.07                         | +15 to +25                                     |
| 17   | 2-6-92                           | 88.27  | 1451   | 1551                                    | 1hr                                   | 1451   | 88.27                      | 67.69                     | 66.05                     | 64.50                     | 65.20                     | 23.07                         | +15 to +25                                     |
| 18   | 2-6-92                           | 88.27  | 1451   | 1551                                    | 1hr                                   | 1451   | 88.27                      | 67.69                     | 66.05                     | 64.50                     | 65.20                     | 23.07                         | +15 to +25                                     |
| 19   | 2-6-92                           | 85.54  | 1925   | 2025                                    | 1hr                                   | 1925   | 85.54                      | 67.57                     | 66.79                     | 64.92                     | 65.63                     | 19.91                         | +15 to +25                                     |
| 20   | 2-6-92                           | 85.54  | 1925   | 2025                                    | 1hr                                   | 1925   | 85.54                      | 67.57                     | 66.79                     | 64.92                     | 65.63                     | 19.91                         | +15 to +25                                     |
| 21   | 3-6-92                           | 74.04  | 0754   | 0854                                    | 1hr                                   | 0754   | 74.04                      | 65.58                     | 65.42                     | 65.41                     | 65.43                     | 8.61                          | +5 to +15                                      |
| 22   | 3-6-92                           | 74.04  | 0754   | 0854                                    | 1hr                                   | 0754   | 74.04                      | 65.58                     | 65.42                     | 65.41                     | 65.43                     | 8.61                          | +5 to +15                                      |
| 23   | 3-6-92                           | 79.04  | 1005   | 1105                                    | 1hr                                   | 1105   | 79.04                      | 66.05                     | 65.61                     | 65.40                     | 65.52                     | 13.52                         | +5 to +15                                      |
| 24   | 3-6-92                           | 79.04  | 1005   | 1105                                    | 1hr                                   | 1105   | 79.04                      | 66.05                     | 65.61                     | 65.40                     | 65.52                     | 13.52                         | +5 to +15                                      |
| 25   | 3-6-92                           | 70.30  | 1133   | 1233                                    | 1hr                                   | 1133   | 70.30                      | 66.93                     | 66.02                     | 65.42                     | 65.72                     | 4.58                          | -5 to +5                                       |
| 26   | 3-6-92                           | 70.30  | 1133   | 1233                                    | 1hr                                   | 1133   | 70.30                      | 66.93                     | 66.02                     | 65.42                     | 65.72                     | 4.58                          | -5 to +5                                       |
| 27   | 3-6-92                           | 70.30  | 1133   | 1233                                    | 1hr                                   | 1133   | 70.30                      | 66.93                     | 66.02                     | 65.42                     | 65.72                     | 4.58                          | -5 to +5                                       |
| 28   | 3-6-92                           | 66.69  | 1247   | 1347                                    | 1hr                                   | 1247   | 66.69                      | 66.58                     | 66.09                     | 65.40                     | 65.68                     | 1.01                          | -5 to +5                                       |
| 29   | 3-6-92                           | 66.69  | 1247   | 1347                                    | 1hr                                   | 1247   | 66.69                      | 66.58                     | 66.09                     | 65.40                     | 65.68                     | 1.01                          | -5 to +5                                       |
| 30   | 5-6-92                           | 64.07  | 1124   | 1224                                    | 1hr                                   | 1124   | 64.07                      | 65.18                     | 65.06                     | 65.53                     | 65.39                     | -1.32                         | -5 to +5                                       |

**Attachment 4 (continued)  
Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation  
Pipeline Leak Detection System  
Options 1 and 5**

| Test No.<br>(Based on<br>Temperature<br>Condition) | Date<br>Test<br>Began<br>(D-M-Y) | Nominal<br>Product<br>Temperature<br>Before<br>Circulation<br>Was Started<br>(deg F) | Time<br>Circulation<br>Started<br>(military) | Time<br>Circulation<br>Ended<br>(deg F) | Duration of<br>Circulation<br>(hr-min) | Time of<br>Temperature<br>Measurements<br>(military) | T <sub>lb</sub><br>(deg F) | T <sub>1</sub><br>(deg F) | T <sub>2</sub><br>(deg F) | T <sub>3</sub><br>(deg F) | T <sub>g</sub><br>(deg F) | T <sub>lb-Tg</sub><br>(deg F) | Temperature<br>Matrix<br>Category<br>(Table 5) |
|--|----------------------------------|--|--|---|--|--|----------------------------|---------------------------|---------------------------|---------------------------|---------------------------|-------------------------------|--|
| 31   | 8-6-92                           | 64.07  | 1124   | 1224                                    | 1hr                                    | 1124   | 64.07                      | 65.18                     | 65.06                     | 65.53                     | 65.39                     | -1.32                         | -5 to +5                                       |
| 32   | 8-6-92                           | 64.07  | 1124   | 1224                                    | 1hr                                    | 1124   | 64.07                      | 65.18                     | 65.06                     | 65.53                     | 65.39                     | -1.32                         | -5 to +5                                       |
| 33   | 8-6-92                           | 61.53  | 1246   | 1346                                    | 1hr                                    | 1246   | 61.53                      | 64.58                     | 64.77                     | 65.53                     | 65.26                     | -3.73                         | -5 to +5                                       |
| 34   | 8-6-92                           | 61.53  | 1246   | 1346                                    | 1hr                                    | 1246   | 61.53                      | 64.58                     | 64.77                     | 65.53                     | 65.26                     | -3.73                         | -5 to +5                                       |
| 35   | 8-6-92                           | 59.92  | 1317   | 1418                                    | 1hr&1min                               | 1317   | 59.92                      | 65.27                     | 65.18                     | 65.49                     | 65.40                     | -5.48                         | -5 to -15                                      |
| 36   | 8-6-92                           | 59.92  | 1317   | 1418                                    | 1hr&1min                               | 1317   | 59.92                      | 65.27                     | 65.18                     | 65.49                     | 65.40                     | -5.48                         | -5 to -15                                      |
| 37   | 8-6-92                           | 59.92  | 1317   | 1418                                    | 1hr&1min                               | 1317   | 59.92                      | 65.27                     | 65.18                     | 65.49                     | 65.40                     | -5.48                         | -5 to -15                                      |
| 38   | 8-6-92                           | 56.92  | 1426   | 1534                                    | 1hr&8min                               | 1426   | 56.92                      | 64.57                     | 64.95                     | 65.56                     | 65.32                     | -8.40                         | -5 to -15                                      |
| 39   | 8-6-92                           | 56.92  | 1426   | 1534                                    | 1hr&8min                               | 1426   | 56.92                      | 64.57                     | 64.95                     | 65.56                     | 65.32                     | -8.40                         | -5 to -15                                      |
| 40   | 8-6-92                           | 56.92  | 1426   | 1534                                    | 1hr&8min                               | 1426   | 56.92                      | 64.57                     | 64.95                     | 65.56                     | 65.32                     | -8.40                         | -5 to -15                                      |
| 41   | 8-6-92                           | 54.26  | 1635   | 1735                                    | 1hr                                    | 1635   | 54.26                      | 63.89                     | 64.36                     | 65.44                     | 65.03                     | -10.77                        | -5 to -15                                      |
| 42   | 8-6-92                           | 54.26  | 1635   | 1735                                    | 1hr                                    | 1635   | 54.26                      | 63.89                     | 64.36                     | 65.44                     | 65.03                     | -10.77                        | -5 to -15                                      |
| 43   | 9-6-92                           | 42.33  | 1322   | 1422                                    | 1hr                                    | 1322   | 42.33                      | 65.13                     | 65.06                     | 65.71                     | 65.50                     | -23.17                        | -15 to -25                                     |
| 44   | 9-6-92                           | 42.33  | 1322   | 1422                                    | 1hr                                    | 1322   | 42.33                      | 65.13                     | 65.06                     | 65.71                     | 65.50                     | -23.17                        | -15 to -25                                     |
| 45   | 9-6-92                           | 42.33  | 1322   | 1422                                    | 1hr                                    | 1322   | 42.33                      | 65.13                     | 65.06                     | 65.71                     | 65.50                     | -23.17                        | -15 to -25                                     |
| 46   | 9-6-92                           | 44.97  | 1430   | 1530                                    | 1hr                                    | 1430   | 44.97                      | 63.73                     | 64.58                     | 65.70                     | 65.23                     | -20.26                        | -15 to -25                                     |
| 47   | 9-6-92                           | 44.97  | 1430   | 1530                                    | 1hr                                    | 1430   | 44.97                      | 63.73                     | 64.58                     | 65.70                     | 65.23                     | -20.26                        | -15 to -25                                     |
| 48   | 9-6-92                           | 44.97  | 1430   | 1530                                    | 1hr                                    | 1430   | 44.97                      | 63.73                     | 64.58                     | 65.70                     | 65.23                     | -20.26                        | -15 to -25                                     |
| 49   | 9-6-92                           | 47.85  | 1634   | 1734                                    | 1hr                                    | 1634   | 47.85                      | 62.20                     | 63.25                     | 65.74                     | 64.80                     | -16.95                        | -15 to -25                                     |
| 50   | 9-6-92                           | 47.85  | 1634   | 1734                                    | 1hr                                    | 1634   | 47.85                      | 62.20                     | 63.25                     | 65.74                     | 64.80                     | -16.95                        | -15 to -25                                     |
| 51   | 9-6-92                           | 50.49  | 1745   | 1845                                    | 1hr                                    | 1745   | 50.49                      | 61.93                     | 62.96                     | 65.68                     | 64.66                     | -14.17                        | -5 to -15                                      |
| 52   | 9-6-92                           | 50.49  | 1745   | 1845                                    | 1hr                                    | 1745   | 50.49                      | 61.93                     | 62.96                     | 65.68                     | 64.66                     | -14.17                        | -5 to -15                                      |

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

| Test No.<br>(Based on<br>Temperature<br>Condition) | Date<br>Test<br>Began<br>(D-M-Y) | Induced<br>Leak Rate<br>(gal/hr) | Time between End<br>of Circulation and<br>Start of Data<br>Collection for Test<br>(h-min) | Time Data<br>Collection<br>Began<br>(military) | Time Data<br>Collection<br>Ended<br>(military) | Test<br>Result<br>(leak or tight) | Was<br>Threshold<br>Exceeded?<br>(yes or no) |
|--|----------------------------------|----------------------------------|---|--|--|-----------------------------------|--|
| 1  | 1-6-92                           | 2.95                             | 6 min   | 1330   | 1331   | leak                              | yes  |
| 2  | 1-6-92                           | 0                                | 8 min   | 1332   | 1333   | tight                             | no   |
| 3  | 1-6-92                           | 2.95                             | 10 min  | 1334   | 1335   | leak                              | yes  |
| 4  | 2-6-92                           | 2.95                             | 1 min   | 0914   | 0915   | leak                              | yes  |
| 5  | 2-6-92                           | 0                                | 3 min   | 0916   | 0917   | tight                             | no   |
| 6  | 2-6-92                           | 2.95                             | 5 min   | 0918   | 0919   | leak                              | yes  |
| 7  | 2-6-92                           | 0                                | 1 min   | 1046   | 1047   | tight                             | no   |
| 8  | 2-6-92                           | 2.95                             | 2 min   | 1047   | 1048   | leak                              | yes  |
| 9  | 2-6-92                           | 0                                | 4 min   | 1049   | 1050   | tight                             | no   |
| 10   | 2-6-92                           | 0                                | 2 min   | 1338   | 1339   | tight                             | no   |
| 11   | 2-6-92                           | 2.95                             | 3 min   | 1339   | 1340   | leak                              | yes  |
| 12   | 2-6-92                           | 0                                | 5 min   | 1341   | 1342   | tight                             | no   |
| 13   | 2-6-92                           | 0                                | 1 min   | 1447   | 1448   | tight                             | no   |
| 14   | 2-6-92                           | 2.95                             | 2 min   | 1448   | 1449   | leak                              | yes  |
| 15   | 2-6-92                           | 0                                | 4 min   | 1450   | 1451   | tight                             | no   |
| 16   | 2-6-92                           | 2.95                             | 1 min   | 1552   | 1553   | leak                              | yes  |
| 17   | 2-6-92                           | 0                                | 2 min   | 1554   | 1555   | tight                             | no   |
| 18   | 2-6-92                           | 2.95                             | 3 min   | 1556   | 1557   | leak                              | yes  |
| 19   | 2-6-92                           | 0                                | 2 min   | 2027   | 2028   | tight                             | no   |
| 20   | 2-6-92                           | 2.95                             | 4 min   | 2029   | 2030   | leak                              | yes  |
| 21   | 3-6-92                           | 2.95                             | 1 min   | 0855   | 0856   | leak                              | yes  |
| 22   | 3-6-92                           | 0                                | 5 min   | 0859   | 0900   | tight                             | no   |
| 23   | 3-6-92                           | 0                                | 1 min   | 1106   | 1107   | tight                             | no   |
| 24   | 3-6-92                           | 2.95                             | 2 min   | 1107   | 1108   | leak                              | yes  |
| 25   | 3-6-92                           | 0                                | 1 min   | 1234   | 1235   | tight                             | no   |
| 26   | 3-6-92                           | 2.95                             | 2 min   | 1235   | 1236   | leak                              | yes  |
| 27   | 3-6-92                           | 0                                | 4 min   | 1237   | 1238   | tight                             | no   |
| 28   | 3-6-92                           | 0                                | 1 min   | 1348   | 1349   | tight                             | no   |
| 29   | 3-6-92                           | 2.95                             | 2 min   | 1349   | 1350   | leak                              | yes  |
| 30   | 5-6-92                           | 2.95                             | 1 min   | 1225   | 1226   | leak                              | yes  |
| 31   | 5-6-92                           | 0                                | 3 min   | 1227   | 1228   | tight                             | no   |
| 32   | 5-6-92                           | 2.95                             | 4 min   | 1228   | 1229   | leak                              | yes  |
| 33   | 5-6-92                           | 2.95                             | 1 min   | 1347   | 1348   | leak                              | yes  |
| 34   | 5-6-92                           | 0                                | 3 min   | 1349   | 1450   | tight                             | no   |
| 35   | 8-6-92                           | 2.95                             | 1 min   | 1419   | 1420   | leak                              | yes  |
| 36   | 8-6-92                           | 0                                | 3 min   | 1421   | 1422   | tight                             | no   |
| 37   | 8-6-92                           | 2.95                             | 4 min   | 1422   | 1423   | leak                              | yes  |
| 38   | 8-6-92                           | 0                                | 1 min   | 1535   | 1536   | tight                             | no   |
| 39   | 8-6-92                           | 2.95                             | 2 min   | 1536   | 1537   | leak                              | yes  |
| 40   | 8-6-92                           | 0                                | 4 min   | 1538   | 1539   | tight                             | no   |
| 41   | 8-6-92                           | 2.95                             | 1 min   | 1736   | 1737   | leak                              | yes  |
| 42   | 8-6-92                           | 0                                | 3 min   | 1738   | 1739   | tight                             | no   |
| 43   | 9-6-92                           | 0                                | 1 min   | 1423   | 1424   | tight                             | no   |
| 44   | 9-6-92                           | 2.95                             | 2 min   | 1424   | 1425   | leak                              | yes  |
| 45   | 9-6-92                           | 0                                | 4 min   | 1426   | 1427   | tight                             | no   |
| 46   | 9-6-92                           | 2.95                             | 1 min   | 1531   | 1532   | leak                              | yes  |
| 47   | 9-6-92                           | 0                                | 3 min   | 1533   | 1534   | tight                             | no   |
| 48   | 9-6-92                           | 2.95                             | 4 min   | 1534   | 1535   | leak                              | yes  |
| 49   | 9-6-92                           | 0                                | 1 min   | 1735   | 1736   | tight                             | no   |
| 50   | 9-6-92                           | 2.95                             | 2 min   | 1736   | 1737   | leak                              | yes  |
| 51   | 9-6-92                           | 0                                | 1 min   | 1846   | 1847   | tight                             | no   |
| 52   | 9-6-92                           | 2.95                             | 2 min   | 1847   | 1848   | leak                              | yes  |

Attachment 6  
 Data Sheet Summarizing the Test Results and the Trapped Vapor Tests  
 Pipeline Leak Detection system  
 Options 1 and 5

Summary of Temperature Conditions

| Nominal Product Temperature Before Circulation Was Started (deg F) | Time Circulation Started (military) | Time Circulation Ended (deg F) | Duration of Circulation (h-min) | Time of Temperature Measurements (military) | T <sub>tb</sub> (deg F) | T <sub>1</sub> (deg F) | T <sub>2</sub> (deg F) | T <sub>3</sub> (deg F) | T <sub>g</sub> (deg F) | T <sub>tb-Tg</sub> (deg F) | Temperature Test Matrix Category (Table 5) |
|--|-------------------------------------|--------------------------------|---------------------------------|---|-------------------------|------------------------|------------------------|------------------------|------------------------|----------------------------|--|
| 57.05  | 0935                                | 1035                           | 1hr                             | 0935  | 57.05                   | 65.94                  | 65.94                  | 65.97                  | 65.96                  | -8.91                      | -5 to -15                                  |
| 57.05  | 0935                                | 1035                           | 1hr                             | 0935  | 57.05                   | 65.94                  | 65.94                  | 65.97                  | 65.96                  | -8.91                      | -5 to -15                                  |
| 63.59  | 1117                                | 1217                           | 1hr                             | 1117  | 63.59                   | 65.11                  | 65.33                  | 65.74                  | 65.74                  | -2.15                      | -5 to +5                                   |

Summary of Leak Rates

| Test No. | Date Test Began (D-M-Y) | Pipeline Pressure (psi) | Induced Leak Rate (gal/h) | Time between End of circulation and Start of Data Collection for Test (h-min) | Time Data Collection Began (military) | Time Data Collection Ended (military) | Measured Test Result (gal/h) | Was Threshold Exceeded? (yes or no) |
|----------|-------------------------|-------------------------|---------------------------|---|---------------------------------------|---------------------------------------|------------------------------|-------------------------------------|
| 1        | 10-6-92                 | 28                      | 0                         | 1 min   | 1036                                  | 196:20                                | tight                        | no                                  |
| 2        | 10-6-92                 | 28                      | 3.25                      | 5 min   | 1039                                  | 1040                                  | leak                         | yes                                 |
| 3        | 10-6-92                 | 28                      | 2.75                      | 1 min   | 1218                                  | 1219                                  | 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*<br>(gal/h) | Measured Leak Rate<br>(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*<br>(gal/h) | Measured Leak Rate<br>(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.