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Certification Reports

Results of U.S. E.P.A. Standard Evaluations

FX1V, FX2V, BFX1V & BFX1DV Leak Detectors

VEEDER-ROOT

Evaluation of the Veeder-Root Fx1V and Fx2V Leak Detectors Installed in the Big Flow or Packer/Manifold on Rigid and Flexible Pipelines

Final Report

PREPARED FOR

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November 21, 2005

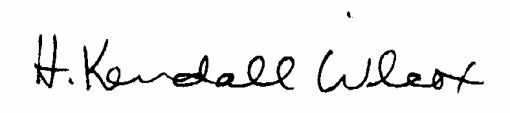
Preface

This report was prepared for Veeder-Root by Ken Wilcox Associates, Inc. This report presents the results of an independent performance evaluation of the Big Flow leak detector using a Red Jacket Fx2V mechanical leak detector as the pilot valve. Testing was conducted with gasoline on both rigid and flexible pipelines. The results in this report can be applied to the Veeder-Root Fx1V and Fx2V.

The purpose of the current testing was to demonstrate that the Big Flow system performs adequately when tested on larger piping including both rigid, flexible, and a combination of both types of pipelines. Testing for this evaluation was performed in accordance with the federal EPA "Standard Test Procedures for Evaluating Leak Detection Methods: "Pipeline Leak Detection Systems", EPA/530/UST-90/010, September, 1990."

The work was conducted at the Fuels Management Research Center which is operated by Ken Wilcox Associates, Inc. This report was prepared by Dr. Ken Wilcox and the laboratory testing conducted by Craig Wilcox. Questions regarding this evaluation should be directed to Mr. Alex Abri, Veeder-Root, at (800) 323-1799

KEN WILCOX ASSOCIATES, INC.



H. Kendall Wilcox, Ph.D.
President
November 21, 2005

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1.0 Introduction

The federal Environmental Protection Agency (EPA) has provided a series of documents that describe the procedures which are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.[1] At the minimum, a leak detector that is capable of detecting leaks of 3.0 gallons per hour (gal/hr) or larger on an hourly basis must be installed on all pressurized piping. The probability of detecting a leak of stated size must be 95% or greater with a probability of a false alarm (declaring a tight line to be leaking) of no more than 5%.

This report presents the results of an evaluation of the performance of the Veeder-Root Big Flow Pipeline Leak Detection System using an FX2V mechanical leak detector as the pilot valve. Two types of pipe line configurations were used during this evaluation: testing on rigid pipe only; and testing on flexline only. Complete sets of 53 tests were conducted for each pipeline configuration, thus meeting all of the requirements for a full EPA evaluation according to the standard EPA procedures for pipeline leak detectors.[2]

1 CFR 280.4

2 Standard Test Procedures for Evaluating Leak Detection Methods: Pressurized Pipeline Leak Detection Systems, EPA/530 UST-90/010, September 1990.

2.0 Overview of Evaluation Procedures

The Big Flow adapter was installed in the pipline system at the KWA Test Facility. A 1.5 H.P. pump motor delivered fuel to the Big Flow unit and from there out to the two pipeline configurations that were used in the evaluation. The flow of temperature-conditioned fuel was passed through both segments of the line simultaneously. At the end of the circulation, the appropriate segment was valved off and a zero leak and a 3 gal/h test were conducted. The second segment was then valved off and the tests repeated.

The temperature of the product in the pipeline tank was varied relative to the surrounding soil temperature. Product was circulated through the line and leaks were induced at rates equivalent to 3 gal/hr at 10 psig as specified in the EPA protocol.[3] The induced leak rates were established during the circulation period either by adjusting the flow of fuel through a flow meter set to 3.0 gal/h at a pressure of 10 psig or as a nonleak condition. The submerged turbine (STP) was turned off at the dispenser end of the line and a test was automatically initiated. Testing continued until an alarm occurred or the controller indicated a pass condition had occurred.

The test results reported by the Veeder-Root system were compared to the leak conditions that were introduced into the line. A total of 53 tests were conducted on each of the pipeline configurations. This evaluation consisted of one leak test and one tight test conducted at each of the temperature differential extremes indicated in Table 1. In addition 3 tests were conducted with vapor in the lines as specified in the protocol.

Table 1. Summary of Temperature Conditions Used in the Evaluation

Minimum Number of Conditions Required	Number of Conditions Used	Range of dT (°F)*
1	2	dT < -25
4	8	-25 = dT < -15
5	10	-15 = dT < -5
5	10	-5 = dT < +5
5	10	+5 = dT < +15
4	8	+15 = dT < +25
1	2	dT > 25
Total = 25	Total = 25 tight + 25 leaks	-----

* ?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.

[3] "Standard Test Procedures for Evaluating Leak Detection Methods: Pressurized Pipeline Leak Detection Systems", EPA/530/UST-90/010, September, 1990.

Briefly summarized, the test procedures were as follows:

1. Product was conditioned in the pipeline tank to the required temperature. The soil temperature was monitored at distances of 2, 4, and 12 inches from the pipeline to determine proper temperature differentials.
2. Product was circulated through the both legs of the pipeline (rigid and flexible) at a combined rate of approximately 30 gal/min for one hour.
3. After valving off the segments of interest, a leak was induced in the line equivalent to 3.0 gal/hr at 10 psig.
4. The submerged pump dispenser switch was shut off and the pressure was reduced to zero.
5. The pump was authorized and the test was automatically conducted by the MLD.
6. This process was repeated for both rigid and flexible pipeline configurations at the end of each circulation.
7. This process was repeated for each of the temperature differentials shown in Table 1.

Since the test times were less than 15 minutes, the protocol allows for conducting 3 tests for each circulation. In this case the test times were less than one minute so that 3 tests could be conducted on each line for each circulation. The entire process of conducting the six tests was usually less than 10 minutes.

3.0 Description of the Testing Location

The Veeder-Root system was evaluated at the Fuels Management Research Center located in Grain Valley, Missouri, which is operated by Ken Wilcox Associates, Inc. Two different pipeline configurations were tested during the evaluation. A summary of the two configurations is provided in Table 2.

Table 2. Description of Pipelines Used in This Evaluation

Line Description	Length of Each Pipe Segment (ft)				
	3.125" dia FRP	4" dia FRP	3" dia Flex	Total Gal.	Bulk Modulus (psi)
Flex Line	30*	0	130	47.7*	8,360
Rigid Line	150	200	0	208.4	34,458

* The National Workgroup does not allow volume of rigid line to be included in flex line volume for purposes of calculating maximum line size.

The flex line tests were conducted on a 3-inch diameter by 130 ft. long flexible line containing unleaded gasoline. There was also a 30-foot long section of rigid line that is 3.125 inches in diameter coming from the STP to the beginning of the flexline. Although the total volume of the line was 59.7 gallons, the National Workgroup on Leak Detection Evaluations (NWGLDE) allows only the inclusion of the volume of the flexible line in the calculations for maximum line volume for the flex line. The line size has accordingly been limited to just the volume of the flex line, which is 47.7 gallons. The bulk modulus, which is a measure of the "stretch" which occurs when the line is pressurized, was 8,360 psi.

The rigid tests were conducted on a 4-inch diameter by 200 ft. long FRP segment also containing gasoline. An additional 3.125-inch diameter for 30 ft of FRP pipe connected to the STP at the beginning of the 4-inch diameter FRP pipe and an additional 150 ft of 3.125-inch diameter FRP pipe followed the 4-inch diameter pipe leading back to the storage tank. The total volume of the line was 208.4 gallons. The bulk modulus was 34,458 psi.

The conditioned product was contained in a 600 gallon steel tank, which was equipped with a standard 1.5 H.P. Red Jacket submersible pump. Product was heated or cooled in the tank by circulating glycol and product through an external heat exchanger. RTD's were located at 2 inches, 4 inches and 12 inches from the line as specified by the EPA protocol. A single temperature probe was located 4 inches from the bottom of the product conditioning tank. The weighted soil temperature and the product tank temperature at the beginning of the test were used to compute the temperature differential.

4.0 Test Results and Discussion

Testing for this evaluation was conducted using procedures specified in the EPA protocol. The results of the evaluation have been calculated using Section 7.4 of the EPA procedures for systems that do not report a leak rate. The results of the data analysis have been summarized in Table 3.

Calculation of P_{FA} and P_D

A total of 50 tests without vapor in the line were conducted for the Hourly Testing mode, which consisted of 25 leak tests and 25 tight tests. Three tests were conducted with vapor in the line, but the results of these tests were not included in the performance calculations. There were no missed detections or false alarms observed for any of the 50 tests. The P_D of a 3.0 gal/hr leak was calculated to be 100% with a confidence interval from 100 to 86.7% and the P_{FA} on tight line was calculated to be 0% with a confidence interval of zero to 13.3%. When a leak was present in the line, test times were all 1 minute or less. When a leak was not present in the line, test times were also all1 minute or less.

Maximum Line Size

The EPA allows for line leak detectors to be used on lines up to twice the size that they were evaluated on. During this testing, the Veeder-Root system was evaluated on a FRP line consisting of a total of 180 ft of 3.125 inch diameter FRP and 200 ft of 4 inch diameter FRP with a total volume of 208.4 gallons. It was also evaluated on a flexible line that was 130 feet in length by 3-inches in diameter plus 30-feet in length by 3.125-inches in diameter. While the total volume of the line as tested was 59.7 gallons, only the volume of the flex line by itself was included in the calculations for the maximum line size. If the EPA protocol limitations are applied to the Veeder-Root system, the results of this evaluation would apply to rigid lines with a total volume of up to 416.7 gallons and flexible pipelines having a maximum volume of 95.4 gallons.

Waiting Times

Waiting times after the delivery of product, after product is circulated through the line or after pumping has stopped are not necessary before valid tests can be conducted. All of the tests were conducted immediately after product circulation through the pipeline was stopped.

Table 3. Performance Parameters for the Veeder-Root Pipeline Leak Detector for the Rigid and Flexible Pipeline Tests Using the EPA Protocol

Parameter	Rigid Value	Flex Value
Probability of False Alarm (P_{FA}) Of a 3.0 gal/hr leak (Hourly	0%	0 %
Confidence Interval for Probability of False Alarm (Hourly P_{FA})	86.7% to 100%	86.7% to 100%
Probability of Detection (P_D) of a 3.0 gal/hr leak (Hourly)	100%	100%
Confidence Interval for Probability of False Alarm (Hourly P_{FA})	0% to 13.3%	0% to 13.3%
Maximum Line Size	416.7 gal	95.4 gal
Waiting Time After Delivery of Product Before Conducting a Test	None	None
Waiting Time After Product Circulation Through Line Before Conducting a Test	None	None
Hourly Test Times with 3.0 gal/hr Leak	Range: 0 to 1 minutes	
Hourly Test Times without Leak	Range: 0 to 1 minutes	

* Volume of flexible section of line only

5.0 Conclusions

The following conclusions are based on the data collected during this evaluation.

1. The Veeder-Root Fx1V and Fx2V Leak Detectors meet the US federal performance requirements for hourly monitoring when Installed in the Big Flow or Packer/Manifold on rigid and flexible Pipelines.
2. The maximum size lines that the system can be installed on are 416.7 gallons for rigid lines and 95.4 gallons for flexible lines.
3. No stabilization times are needed after dispensing of product through the line have been completed.

Appendix A.

EPA Forms for Evaluation of the Veeder-Root Fx1V and Fx2V Leak Detectors Installed in the Big Flow or Packer/Manifold on Rigid 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

Name Veeder-Root Fx2V installed in the Big Flow or Packer/Manifold

Version number(s) Rigid Lines (applies to Fx1V also)

Vendor Veeder-Root
(Name of Manufacturer)

125 Powder Forest Drive, P.O. Box 2003
(Address)

Simsbury,	CT	06070-7684	(800) 323-1799
(City)	(State)	(Zip Code)	(Phone)

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 % with a confidence interval from 0 % to 13.3 %

   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 %. With a confidence interval from 86.7 % to 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 1.5 gal/h @ 10 psi (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 line(s) between 25 May 05 (date) and 7 June 05 (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 two sections of pipeline used in the evaluation were 3.125 and 4 in. in diameter, 180 and 200 ft long and constructed of FRP (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. NOT APPLICABLE

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
    ( ) 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 dT(°F)**
1	2	dT < -25
4	8	-25 ≤ dT < -15
5	10	-15 ≤ dT < -5
5	10	-5 ≤ dT < +5
5	10	+5 ≤ dT < +15
4	8	+15 ≤ dT < +25
1	2	dT > 25

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

**? 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 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 (see Attachment 6 for additional tests)

Test No.	dT (°F)	Induced Leak Rate (gal/h @ 10 psi)	Measured Leak Rate (gal/h)
51	-7.7	3	Leak detected
52	-7.7	0	Tight
53	-7.7	3	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.)

Quantity Measured:	Temperature	Volume	Time (ms)
Resolution:	0.01 deg F	1%	10
Precision:	0.03 deg F	2%	10
Accuracy:	0.10 deg F	4%	10
Minimum Detectable Quantity:	0.04 deg F	1%	10
Response Time:	2 min	N/A	10

Threshold is exceeded when the flow rate due to a leak exceeds 1.5 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 350 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 variable min (depends on line characteristics)
- 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

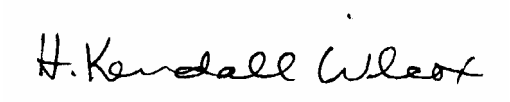
Attachment 6 - Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

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
(name of person performing evaluation)



(signature)

November 21, 2005
(date)

(816) 443-2494
(telephone number)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

1125 Valley Ridge Drive
(street address)

Grain Valley, MO 64039
(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: Veeder-Root Fx2V Installed in Big Flow or Packer/Manifold
Date: November 21, 2005

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 (Contact manufacturer for solvent applications)
   ( ) waste oil
   (X) other (specify) Contact manufacturer for other hydrocarbon applications.

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

   (X) fiberglass
   (X) steel
   (X) other (specify) any rigid piping

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.
   (X) between 3 and 6 in. Contact manufacturer for application to lines greater than 3 in.
   (X) 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

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
   ( ) triggers an alarm
   ( ) alerts the operator
   ( ) shuts down the dispensing system
   (X) other (Restricts flow of fuel to vehicle)

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

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.)
    (X) 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 h (single test) (unit is permanently installed in the line)
_____ 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 (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?

(X) manually
( ) by strip chart
( ) 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
( ) automatically done with a computer program
( ) automatically done with a microprocessor
(X) no calculations – this is a mechanical system

Detection Criterion

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

gal/hr (in the units used by the measurement system)
1.5 @ 10 psi (in gal/h) at operating pressure

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

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	100	0	1.5 @ 10 psi
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

Rigid Pipeline

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.)[1]	4 in. / 3 1/8 in.
Length of pipeline (tank to dispenser) (ft) [1]	200 ft. / 180 ft.
Volume of product in line during testing (gal) [1]	130.6/ 71.8 = 208.4 gal
Type of material (fiberglass, steel, other[2])	FRP
Type of product in tank and pipeline (gasoline, diesel, other[3])	Gasoline
Was a mechanical line leak detector present? (yes or no)	Yes
Was trapped vapor present? (yes or no)	Yes (in 3 tests)
Bulk Modulus (B) (psi)	34,458
B/V_o (psi/ml)	0.0450
Storage tank capacity (gal)	600 gal

[3]Piping consisted of 150 feet of FRP pipe with 3 1/8 in. inside diameter connected to the pump and 200 feet of FRP pipe with 4 in. inside diameter; dimensions and volumes are for each section.
[2]Specify type of construction material. Note: two sections as indicated.
[3]Specify type of product for each tank.

Attachment 4

Veeder-Root Fx2Vi n Big Flow or Packer/Manifold

Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation

Hourly Testing on Rigid Pipelines - 3.0 gal/hr leak tests

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	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(local military)	(local military)	(h-min)	(local military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
1	25-May-05	65.3	930	1030	1	930	65.3	64.7	64.6	64.7	64.7	0.6	-5 to +5
2	25-May-05	65.3	930	1030	1	930	65.3	64.7	64.6	64.7	64.7	0.6	-5 to +5
3	25-May-05	65.3	930	1030	1	930	65.3	64.7	64.6	64.7	64.7	0.6	-5 to +5
4	25-May-05	66.9	1055	1155	1	1055	66.9	64.7	64.7	64.7	64.7	2.2	-5 to +5
5	25-May-05	66.9	1055	1155	1	1055	66.9	64.7	64.7	64.7	64.7	2.2	-5 to +5
6	25-May-05	66.9	1055	1155	1	1055	66.9	64.7	64.7	64.7	64.7	2.2	-5 to +5
7	25-May-05	68.4	1330	1430	1	1330	68.4	64.8	64.7	64.8	64.8	3.6	-5 to +5
8	25-May-05	68.4	1330	1430	1	1330	68.4	64.8	64.7	64.8	64.8	3.6	-5 to +5
9	25-May-05	68.4	1330	1430	1	1330	68.4	64.8	64.7	64.8	64.8	3.6	-5 to +5
10	25-May-05	69.1	1500	1600	1	1500	69.1	65	64.8	64.7	64.8	4.3	-5 to +5
11	26-May-05	76.1	955	1055	1	955	76.1	65.1	65.1	65	65	11.1	+5 to +15
12	26-May-05	76.1	955	1055	1	955	76.1	65.1	65.1	65	65	11.1	+5 to +15
13	26-May-05	76.1	955	1055	1	955	76.1	65.1	65.1	65	65	11.1	+5 to +15
14	26-May-05	78.2	1132	1232	1	1132	78.2	65.5	65.2	65	65.1	13.1	+5 to +15
15	26-May-05	78.2	1132	1232	1	1132	78.2	65.5	65.2	65	65.1	13.1	+5 to +15
16	26-May-05	78.2	1132	1232	1	1132	78.2	65.5	65.2	65	65.1	13.1	+5 to +15
17	26-May-05	80	1405	1505	1	1405	80	65.8	65.3	65.2	65.3	14.7	+5 to +15
18	26-May-05	80	1405	1505	1	1405	80	65.8	65.3	65.2	65.3	14.7	+5 to +15
19	26-May-05	80	1405	1505	1	1405	80	65.8	65.3	65.2	65.3	14.7	+5 to +15
20	26-May-05	77.4	1547	1647	1	1547	77.4	66.4	65.7	65.3	65.5	11.9	+5 to +15
21	27-May-05	83.3	1011	1111	1	1011	83.3	66	65.6	65.5	65.6	17.7	+15 to +25
22	27-May-05	83.3	1011	1111	1	1011	83.3	66	65.6	65.5	65.6	17.7	+15 to +25
23	27-May-05	83.3	1011	1111	1	1011	83.3	66	65.6	65.5	65.6	17.7	+15 to +25
24	27-May-05	87.2	1122	1222	1	1122	87.2	67.3	66.1	65.8	66	21.2	+15 to +25
25	27-May-05	87.2	1122	1222	1	1122	87.2	67.3	66.1	65.8	66	21.2	+15 to +25
26	27-May-05	87.2	1122	1222	1	1122	87.2	67.3	66.1	65.8	66	21.2	+15 to +25
27	31-May-05	92.9	1300	1400	1	1300	92.9	66.9	66.8	66.9	66.9	26	>+25
28	31-May-05	92.9	1300	1400	1	1300	92.9	66.9	66.8	66.9	66.9	26	>+25

Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation

Hourly Testing on Rigid Pipelines - 3.0 gal/hr leak tests

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	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(local military)	(local military)	(h-min)	(local military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
29	31-May-05	88.9	1440	1540	1	1440	88.9	69.9	67.8	67.1	67.6	21.3	+15 to +25
30	31-May-05	88.9	1440	1540	1	1440	88.9	69.9	67.8	67.1	67.6	21.3	+15 to +25
31	1-Jun-05	60.5	1610	1710	1	1610	60.5	71.4	68.9	67.4	68.1	-7.6	-5 to -15
32	1-Jun-05	60.5	1610	1710	1	1610	60.5	71.4	68.9	67.4	68.1	-7.6	-5 to -15
33	1-Jun-05	60.5	1610	1710	1	1610	60.5	71.4	68.9	67.4	68.1	-7.6	-5 to -15
34	2-Jun-05	51.6	1050	1150	1	1050	51.6	67.3	67.3	67.3	67.3	-15.7	-15 to -25
35	2-Jun-05	51.6	1050	1150	1	1050	51.6	67.3	67.3	67.3	67.3	-15.7	-15 to -25
36	2-Jun-05	51.6	1050	1150	1	1050	51.6	67.3	67.3	67.3	67.3	-15.7	-15 to -25
37	2-Jun-05	48.4	1310	1410	1	1310	48.4	63.6	66.8	67.3	66.8	-18.4	-15 to -25
38	2-Jun-05	48.4	1310	1410	1	1310	48.4	63.6	66.8	67.3	66.8	-18.4	-15 to -25
39	2-Jun-05	48.4	1310	1410	1	1310	48.4	63.6	66.8	67.3	66.8	-18.4	-15 to -25
40	2-Jun-05	39.9	1445	1545	1	1445	39.9	61.6	66.4	67.2	66.4	-26.5	<-25
41	2-Jun-05	39.9	1445	1545	1	1445	39.9	61.6	66.4	67.2	66.4	-26.5	<-25
42	2-Jun-05	46.8	1610	1710	1	1610	46.8	60.7	65.9	67.1	66.1	-19.3	-15 to -25
43	2-Jun-05	46.8	1610	1710	1	1610	46.8	60.7	65.9	67.1	66.1	-19.3	-15 to -25
44	6-Jun-05	57.8	1033	1133	1	1033	57.8	67.1	67.3	67.3	67.3	-9.5	-5 to -15
45	6-Jun-05	57.8	1033	1133	1	1033	57.8	67.1	67.3	67.3	67.3	-9.5	-5 to -15
46	6-Jun-05	57.8	1033	1133	1	1033	57.8	67.1	67.3	67.3	67.3	-9.5	-5 to -15
47	6-Jun-05	60.1	1150	1250	1	1150	60.1	66.8	67.2	67.2	67.2	-7.1	-5 to -15
48	6-Jun-05	60.1	1150	1250	1	1150	60.1	66.8	67.2	67.2	67.2	-7.1	-5 to -15
49	6-Jun-05	60.1	1150	1250	1	1150	60.1	66.8	67.2	67.2	67.2	-7.1	-5 to -15
50	7-Jun-05	59.6	1055	1155	1	1055	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15

Attachment 5

Hourly Testing on Rigid Pipelines - 3.0 gal/hr leak tests

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

Pipeline Leak Detection System
Options 1 and 5

Test No. (Based on Temperature Condition)	Date Test Began	Induced Leak Rate	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)	(gal/h)	(h-min)	(local military)	(local military)	(leak or tight)	(yes or no)
1	25-May-05	3.0	6	10:36	10:37	3.0	yes
2	25-May-05	0.0	7	10:37	10:37	0.0	no
3	25-May-05	3.0	8	10:38	10:39	3.0	yes
4	25-May-05	0.0	5	12:00	12:00	0.0	no
5	25-May-05	3.0	6	12:01	12:02	3.0	yes
6	25-May-05	0.0	7	12:02	12:02	0.0	no
7	25-May-05	3.0	8	14:38	14:38	3.0	yes
8	25-May-05	0.0	9	14:39	14:39	0.0	no
9	25-May-05	3.0	10	14:40	14:41	3.0	yes
10	25-May-05	0.0	5	16:05	16:05	0.0	no
11	26-May-05	3.0	6	11:01	11:01	3.0	yes
12	26-May-05	0.0	7	11:02	11:02	0.0	no
13	26-May-05	3.0	8	11:03	11:04	3.0	yes
14	26-May-05	0.0	6	12:38	12:38	0.0	no
15	26-May-05	3.0	7	12:39	12:40	3.0	yes
16	26-May-05	0.0	8	12:40	12:40	0.0	no
17	26-May-05	0.0	6	15:11	15:11	0.0	no
18	26-May-05	3.0	7	15:12	15:13	3.0	yes
19	26-May-05	0.0	8	15:13	15:13	0.0	no
20	26-May-05	3.0	7	16:54	16:55	3.0	yes
21	27-May-05	3.0	7	11:18	11:19	3.0	yes
22	27-May-05	0.0	8	11:19	11:19	0.0	no
23	27-May-05	3.0	8	11:19	11:20	3.0	yes
24	27-May-05	0.0	5	12:27	12:27	0.0	no
25	27-May-05	3.0	6	12:28	12:29	3.0	yes
26	27-May-05	0.0	7	12:29	12:29	0.0	no
27	31-May-05	0.0	5	14:05	14:05	0.0	no
28	31-May-05	3.0	6	14:06	14:07	3.0	yes
29	31-May-05	0.0	5	15:45	15:45	0.0	no
30	31-May-05	3.0	5	15:45	15:46	3.0	yes
31	1-Jun-05	3.0	5	17:15	17:16	3.0	yes
32	1-Jun-05	0.0	6	17:16	17:16	0.0	no
33	1-Jun-05	3.0	7	17:17	17:18	3.0	yes
34	2-Jun-05	3.0	7	11:57	11:58	3.0	yes
35	2-Jun-05	0.0	8	11:58	11:58	0.0	no

Attachment 5

Hourly Testing on Rigid Pipelines - 3.0 gal/hr leak tests

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

Pipeline Leak Detection System

Options 1 and 5

Test No. (Based on Temperature Condition)	Date Test Began	Induced Leak Rate	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)	(gal/h)	(h-min)	(local military)	(local military)	(leak or tight)	(yes or no)
36	2-Jun-05	3.0	9	11:59	12:00	3.0	yes
37	2-Jun-05	0.0	5	14:15	14:15	0.0	no
38	2-Jun-05	3.0	6	14:16	14:17	3.0	yes
39	2-Jun-05	0.0	7	14:17	14:17	0.0	no
40	2-Jun-05	0.0	15	16:00	16:00	0.0	no
41	2-Jun-05	3.0	17	16:02	16:03	3.0	yes
42	2-Jun-05	0.0	3	17:13	17:13	0.0	no
43	2-Jun-05	3.0	3	17:13	17:14	3.0	yes
44	6-Jun-05	0.0	5	10:38	10:38	0.0	no
45	6-Jun-05	3.0	6	10:39	10:40	3.0	yes
46	6-Jun-05	0.0	7	10:40	10:40	0.0	no
47	6-Jun-05	3.0	6	11:56	11:57	3.0	yes
48	6-Jun-05	0.0	7	11:57	11:57	0.0	no
49	6-Jun-05	3.0	8	11:58	11:59	3.0	yes
50	7-Jun-05	0.0	7	10:59	10:59	0.0	no

Attachment 6

Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Pipeline Leak Detection System
Options 1 and 5
Hourly Testing on Rigid Pipelines - 3.0 gal/hr leak tests
Summary of Temperature Conditions

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	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(local military)	(local military)	(h-min)	(local military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
51	07-Jun-05	59.60	0955	1055	1	0955	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15
52	07-Jun-05	59.60	0955	1055	1	0955	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15
53	07=Jun-05	59.60	0955	1055	1	0955	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15

Summary of Leak Rates

Test No.	Date Test Began	Pipeline Pressure	Induced Leak Rate	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-min)	(local military)	(local military)	(leak or tight)	(yes or no)
51	07-Jun-05	30	3.0	0:05	1100	1101	Leak	yes
52	07-Jun-05	30	0.0	0:06	1101	1102	Tight	no
53	07-Jun-05	30	3.0	0:07	1103	1104	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.

Appendix B

EPA Forms for Evaluation of the Veeder-Root Fx1V and Fx2V Leak Detectors Installed in the Big Flow or Packer/Manifold 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

Name Veeder-Root Fx2V installed in the Big Flow or Packer/Manifold

Version number(s) Flexible Lines (applies to Fx1V also)

Vendor Veeder-Root
(Name of Manufacturer)

125 Powder Forest Drive, P.O. Box 2003
(Address)

Simsbury,	CT	06070-7684	(800) 323-1799
(City)	(State)	(Zip Code)	(Phone)

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 1.5 gal/h @ 10 psi (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 line(s) between 25 May 05 (date) and 7 June 05 (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, 130 ft long and constructed of flexible materials (fiberglass, steel, or other)plus a section 3.125 in. in diameter, 30 ft long and constructed of FRP.

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. NOT APPLICABLE

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
    ( ) 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 dT(°F)**
1	2	$dT < -25$
4	8	$-25 \leq dT < -15$
5	10	$-15 \leq dT < -5$
5	10	$-5 \leq dT < +5$
5	10	$+5 \leq dT < +15$
4	8	$+15 \leq dT < +25$
1	2	$dT > 25$

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

**? 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 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 (see Attachment 6 for additional tests)

Test No.	dT (°F)	Induced Leak Rate (gal/h @ 10 psi)	Measured Leak Rate (gal/h)
51	-7.7	3	Leak detected
52	-7.7	0	Tight
53	-7.7	3	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.)

Quantity Measured:	Temperature	Volume	Time (ms)
Resolution:	0.01 deg F	1%	10
Precision:	0.03 deg F	2%	10
Accuracy:	0.10 deg F	4%	10
Minimum Detectable Quantity:	0.04 deg F	1%	10
Response Time:	2 min	N/A	10

Threshold is exceeded when the flow rate due to a leak exceeds 1.5 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 350 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
( ) is present in
(X) 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 variable min (depends on line characteristics)

- 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

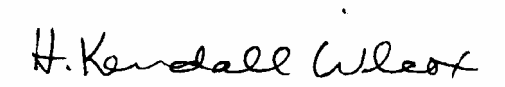
Attachment 7 - Data Sheet Summarizing the Test Results Used to Check the Relationship Supplied by the Manufacturer for Combining the Signal and Noise

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
(name of person performing evaluation)

Ken Wilcox Associates, Inc.
(organization performing evaluation)



(signature)

1125 Valley Ridge Drive
(street address)

November 21, 2005
(date)

Grain Valley, MO 64039
(city, state, zip)

(816) 443-2494
(telephone number)

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: Veeder-Root Fx2V installed in the Big Flow or Packer/Manifold

Date November 21, 2005

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 (Contact manufacturer for solvent applications)
   ( ) waste oil
   (X) other (specify) Contact manufacturer for other hydrocarbon applications.

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

   (X) fiberglass
   (X) steel
   (X) other (specify) any flexible piping

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.
   (X) between 3 and 6 in. Contact manufacturer for application to lines greater than 3 in.
   (X) 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

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
   ( ) triggers an alarm
   ( ) alerts the operator
   ( ) shuts down the dispensing system
   (X) other (Restricts flow of fuel to vehicle)

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

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.)
    (X) 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 h (single test) (unit is permanently installed in the line)
_____ 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 (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?

(X) manually
( ) by strip chart
( ) 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
( ) automatically done with a computer program
( ) automatically done with a microprocessor
(X) no calculations – this is a mechanical system

Detection Criterion

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

gal/hr (in the units used by the measurement system)
1.5 @ 10 psi (in gal/h) at operating pressure

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

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	100	0	1.5 @ 10 psi
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

Flexible Pipeline

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.)[1]	3 in / 3 1/8 in
Length of pipeline (tank to dispenser) (ft) [1]	130 ft. / 30 ft.
Volume of product in line during testing (gal) [1]	47.74 gal*
Type of material (fiberglass, steel, other)	Flex/FRP
Type of product in tank and pipeline (gasoline, diesel, other)	Gasoline
Was a mechanical line leak detector present? (yes or no)	Yes
Was trapped vapor present? (yes or no)	Yes (in 3 tests)
Bulk Modulus (B) (psi)	8360
B/V_o (psi/ml)	0.037
Storage tank capacity (gal)	600 gal

[1] Piping consisted of 30 feet of FRP pipe with 3 1/8 in. inside diameter connected to the pump and 130 feet of flexible pipe with 3 in. inside diameter. The total line volume was 59.4 gallons.

Attachment 4

Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation

Hourly Testing on Flex Pipelines - 3.0 gal/hr leak tests

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	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(local military)	(local military)	(h-min)	(local military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
1	25-May-05	65.3	930	1030	1	930	65.3	64.7	64.6	64.7	64.7	0.6	-5 to +5
2	25-May-05	65.3	930	1030	1	930	65.3	64.7	64.6	64.7	64.7	0.6	-5 to +5
3	25-May-05	65.3	930	1030	1	930	65.3	64.7	64.6	64.7	64.7	0.6	-5 to +5
4	25-May-05	66.9	1055	1155	1	1055	66.9	64.7	64.7	64.7	64.7	2.2	-5 to +5
5	25-May-05	66.9	1055	1155	1	1055	66.9	64.7	64.7	64.7	64.7	2.2	-5 to +5
6	25-May-05	66.9	1055	1155	1	1055	66.9	64.7	64.7	64.7	64.7	2.2	-5 to +5
7	25-May-05	68.4	1330	1430	1	1330	68.4	64.8	64.7	64.8	64.8	3.6	-5 to +5
8	25-May-05	68.4	1330	1430	1	1330	68.4	64.8	64.7	64.8	64.8	3.6	-5 to +5
9	25-May-05	68.4	1330	1430	1	1330	68.4	64.8	64.7	64.8	64.8	3.6	-5 to +5
10	25-May-05	69.1	1500	1600	1	1500	69.1	65	64.8	64.7	64.8	4.3	-5 to +5
11	26-May-05	76.1	955	1055	1	955	76.1	65.1	65.1	65	65	11.1	+5 to +15
12	26-May-05	76.1	955	1055	1	955	76.1	65.1	65.1	65	65	11.1	+5 to +15
13	26-May-05	76.1	955	1055	1	955	76.1	65.1	65.1	65	65	11.1	+5 to +15
14	26-May-05	78.2	1132	1232	1	1132	78.2	65.5	65.2	65	65.1	13.1	+5 to +15
15	26-May-05	78.2	1132	1232	1	1132	78.2	65.5	65.2	65	65.1	13.1	+5 to +15
16	26-May-05	78.2	1132	1232	1	1132	78.2	65.5	65.2	65	65.1	13.1	+5 to +15
17	26-May-05	80	1405	1505	1	1405	80	65.8	65.3	65.2	65.3	14.7	+5 to +15
18	26-May-05	80	1405	1505	1	1405	80	65.8	65.3	65.2	65.3	14.7	+5 to +15
19	26-May-05	80	1405	1505	1	1405	80	65.8	65.3	65.2	65.3	14.7	+5 to +15
20	26-May-05	77.4	1547	1647	1	1547	77.4	66.4	65.7	65.3	65.5	11.9	+5 to +15
21	27-May-05	83.3	1011	1111	1	1011	83.3	66	65.6	65.5	65.6	17.7	+15 to +25
22	27-May-05	83.3	1011	1111	1	1011	83.3	66	65.6	65.5	65.6	17.7	+15 to +25
23	27-May-05	83.3	1011	1111	1	1011	83.3	66	65.6	65.5	65.6	17.7	+15 to +25
24	27-May-05	87.2	1122	1222	1	1122	87.2	67.3	66.1	65.8	66	21.2	+15 to +25
25	27-May-05	87.2	1122	1222	1	1122	87.2	67.3	66.1	65.8	66	21.2	+15 to +25
26	27-May-05	87.2	1122	1222	1	1122	87.2	67.3	66.1	65.8	66	21.2	+15 to +25
27	31-May-05	92.9	1300	1400	1	1300	92.9	66.9	66.8	66.9	66.9	26	>+25
28	31-May-05	92.9	1300	1400	1	1300	92.9	66.9	66.8	66.9	66.9	26	>+25

Attachment 4

Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation

Hourly Testing on Flex Pipelines - 3.0 gal/hr leak tests

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	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(local military)	(local military)	(h-min)	(local military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
29	31-May-05	88.9	1440	1540	1	1440	88.9	69.9	67.8	67.1	67.6	21.3	+15 to +25
30	31-May-05	88.9	1440	1540	1	1440	88.9	69.9	67.8	67.1	67.6	21.3	+15 to +25
31	1-Jun-05	60.5	1610	1710	1	1610	60.5	71.4	68.9	67.4	68.1	-7.6	-5 to -15
32	1-Jun-05	60.5	1610	1710	1	1610	60.5	71.4	68.9	67.4	68.1	-7.6	-5 to -15
33	1-Jun-05	60.5	1610	1710	1	1610	60.5	71.4	68.9	67.4	68.1	-7.6	-5 to -15
34	2-Jun-05	51.6	1050	1150	1	1050	51.6	67.3	67.3	67.3	67.3	-15.7	-15 to -25
35	2-Jun-05	51.6	1050	1150	1	1050	51.6	67.3	67.3	67.3	67.3	-15.7	-15 to -25
36	2-Jun-05	51.6	1050	1150	1	1050	51.6	67.3	67.3	67.3	67.3	-15.7	-15 to -25
37	2-Jun-05	48.4	1310	1410	1	1310	48.4	63.6	66.8	67.3	66.8	-18.4	-15 to -25
38	2-Jun-05	48.4	1310	1410	1	1310	48.4	63.6	66.8	67.3	66.8	-18.4	-15 to -25
39	2-Jun-05	48.4	1310	1410	1	1310	48.4	63.6	66.8	67.3	66.8	-18.4	-15 to -25
40	2-Jun-05	39.9	1445	1545	1	1445	39.9	61.6	66.4	67.2	66.4	-26.5	<-25
41	2-Jun-05	39.9	1445	1545	1	1445	39.9	61.6	66.4	67.2	66.4	-26.5	<-25
42	2-Jun-05	46.8	1610	1710	1	1610	46.8	60.7	65.9	67.1	66.1	-19.3	-15 to -25
43	2-Jun-05	46.8	1610	1710	1	1610	46.8	60.7	65.9	67.1	66.1	-19.3	-15 to -25
44	6-Jun-05	57.8	1033	1133	1	1033	57.8	67.1	67.3	67.3	67.3	-9.5	-5 to -15
45	6-Jun-05	57.8	1033	1133	1	1033	57.8	67.1	67.3	67.3	67.3	-9.5	-5 to -15
46	6-Jun-05	57.8	1033	1133	1	1033	57.8	67.1	67.3	67.3	67.3	-9.5	-5 to -15
47	6-Jun-05	60.1	1150	1250	1	1150	60.1	66.8	67.2	67.2	67.2	-7.1	-5 to -15
48	6-Jun-05	60.1	1150	1250	1	1150	60.1	66.8	67.2	67.2	67.2	-7.1	-5 to -15
49	6-Jun-05	60.1	1150	1250	1	1150	60.1	66.8	67.2	67.2	67.2	-7.1	-5 to -15
50	7-Jun-05	59.6	1055	1155	1	1055	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15

Attachment 5

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

Hourly Testing on Flex Pipelines - 3.0 gal/hr leak tests
Pipeline Leak Detection System
Options 1 and 5

Test No. (Based on Temperature Condition)	Date Test Began	Induced Leak Rate	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)	(gal/h)	(h-min)	(local military)	(local military)	(leak or tight)	(yes or no)
1	25-May-05	3.0	12	10:42	10:43	3.0	yes
2	25-May-05	0.0	14	10:44	10:44	0.0	no
3	25-May-05	3.0	14	10:44	10:45	3.0	yes
4	25-May-05	0.0	10	12:05	12:05	0.0	no
5	25-May-05	3.0	11	12:06	12:07	3.0	yes
6	25-May-05	0.0	12	12:07	12:07	0.0	no
7	25-May-05	3.0	16	14:46	14:47	3.0	yes
8	25-May-05	0.0	17	14:47	14:47	0.0	no
9	25-May-05	3.0	18	14:48	14:49	3.0	yes
10	25-May-05	0.0	8	16:08	16:08	0.0	no
11	26-May-05	3.0	12	11:07	11:08	3.0	yes
12	26-May-05	0.0	13	11:08	11:08	0.0	no
13	26-May-05	3.0	14	11:09	11:10	3.0	yes
14	26-May-05	0.0	13	12:45	12:45	0.0	no
15	26-May-05	3.0	14	12:46	12:47	3.0	yes
16	26-May-05	0.0	16	12:48	12:48	0.0	no
17	26-May-05	0.0	10	15:15	15:15	0.0	no
18	26-May-05	3.0	11	15:16	15:17	3.0	yes
19	26-May-05	0.0	12	15:17	15:17	0.0	no
20	26-May-05	3.0	14	17:01	17:02	3.0	yes
21	27-May-05	3.0	12	11:23	11:24	3.0	yes
22	27-May-05	0.0	13	11:24	11:24	0.0	no
23	27-May-05	3.0	14	11:25	11:26	3.0	yes
24	27-May-05	0.0	11	12:33	12:33	0.0	no
25	27-May-05	3.0	11	12:33	12:34	3.0	yes
26	27-May-05	0.0	12	12:34	12:34	0.0	no
27	31-May-05	0.0	10	14:10	14:10	0.0	no
28	31-May-05	3.0	10	14:10	14:11	3.0	yes
29	31-May-05	0.0	9	15:49	15:49	0.0	no
30	31-May-05	3.0	10	15:50	15:51	3.0	yes
31	1-Jun-05	3.0	11	17:21	17:22	3.0	yes
32	1-Jun-05	0.0	12	17:22	17:22	0.0	no
33	1-Jun-05	3.0	13	17:22	17:23	3.0	yes
34	2-Jun-05	3.0	14	12:04	12:05	3.0	yes
35	2-Jun-05	0.0	15	12:05	12:05	0.0	no

Attachment 5

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

Hourly Testing on Flex Pipelines - 3.0 gal/hr leak tests
Pipeline Leak Detection System
Options 1 and 5

Test No. (Based on Temperature Condition)	Date Test Began	Induced Leak Rate	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)	(gal/h)	(h-min)	(local military)	(local military)	(leak or tight)	(yes or no)
36	2-Jun-05	3.0	16	12:06	12:06	3.0	yes
37	2-Jun-05	0.0	11	14:21	14:21	0.0	no
38	2-Jun-05	3.0	12	14:22	14:22	3.0	yes
39	2-Jun-05	0.0	13	14:23	14:23	0.0	no
40	2-Jun-05	0.0	3	15:48	15:48	0.0	no
41	2-Jun-05	3.0	4	15:49	15:50	3.0	yes
42	2-Jun-05	0.0	7	17:17	17:17	0.0	no
43	2-Jun-05	3.0	8	17:18	17:19	3.0	yes
44	6-Jun-05	0.0	11	10:44	10:44	0.0	no
45	6-Jun-05	3.0	12	10:45	10:46	3.0	yes
46	6-Jun-05	0.0	13	10:46	10:46	0.0	no
47	6-Jun-05	3.0	13	12:03	12:04	3.0	yes
48	6-Jun-05	0.0	14	12:04	12:04	0.0	no
49	6-Jun-05	3.0	15	12:05	12:06	3.0	yes
50	7-Jun-05	0.0	10	11:05	11:05	0.0	no

Attachment 6

Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Pipeline Leak Detection System
Options 1 and 5
Hourly Testing on Flex Pipelines - 3.0 gal/hr leak tests
Summary of Temperature Conditions

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	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(local military)	(local military)	(h-min)	(local military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
51	07-Jun-05	59.60	0955	1055	1	0955	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15
52	07-Jun-05	59.60	0955	1055	1	0955	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15
53	07-Jun-05	59.60	0955	1055	1	0955	59.6	67.2	67.2	67.3	67.3	-7.7	-5 to -15

Summary of Leak Rates

Test No.	Date Test Began	Pipeline Pressure	Induced Leak Rate	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-min)	(local military)	(local military)	(leak or tight)	(yes or no)
51	07-Jun-05	30	3.0	0:11	1106	1107	Leak	yes
52	07-Jun-05	30	0.0	0:12	1107	1107	Tight	no
53	07-Jun-05	30	3.0	0:13	1108	1109	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.

Evaluation of the Veeder-Root BFX1V Mechanical Pipeline Leak Detector, STP Mounted, for Hourly Testing on Rigid, Flexible and Hybrid Pipelines

Final Report Version 1

PREPARED FOR

Veeder-Root
125 Powder Forest Drive
Post Office Box 2003
Simsbury, Connecticut 06070-2003

November 10, 2023

Preface

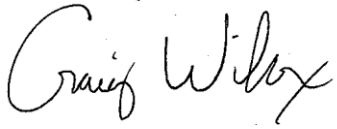
This report was prepared for Veeder-Root by Ken Wilcox Associates, Inc. This report presents the results of an independent performance evaluation of the Veeder-Root BFX1V Mechanical Pipeline Leak Detector(MLLD), when mounted in a Submersible Turbine Pump(STP), for use on rigid, flexible, and combined pipelines.

This report covers the performance of the BFX1V MLLD, when mounted in an STP, for Hourly (3gph) testing for pressurized piping. The purpose of the current testing is to show that the system performs adequately when tested on rigid, flexible as well as hybrid piping. Testing for this evaluation was performed in accordance with the US EPA protocol “Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection”, May 2019. The results indicate that the BFX1V MLLD when mounted in an STP will successfully detect a leak of 3gph on flexible, rigid and hybrid pipeline systems.

The work was conducted at the Fuels Management Research Center, which is operated by Ken Wilcox Associates, Inc. This report was prepared by Craig D Wilcox for, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to the Veeder-Root Engineering Department at 860-651-2700.

November 10, 2023 KEN WILCOX ASSOCIATES, INC.

Approved:



Craig D Wilcox
President

Table of Contents

Executive Summary

This report presents the results of an independent evaluation of the BFX1V MLLD when mounted in an STP for hourly testing on flexible, rigid and combination pipelines. The test procedures used were those described in the US EPA protocol “Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection”, May 2019.

The performance capabilities of the BFX1V MLLD, when mounted in an STP, were determined for Hourly Testing. The BFX1V MLLD, when mounted in an STP, met the US EPA performance standards for hourly pipeline leak detection systems which require a probability of detecting a leak of stated size be 95% or greater with a probability of false alarm (declaring a tight line to be leaking) of no more than 5%.

The BFX1V MLLD, when mounted in an STP, was tested on a pipeline consisting of rigid, semi-rigid and flexible pipe. The total line volume for hourly testing was 589.34 gallons of unleaded gasoline with a bulk modulus of 17,052 psi. The pipeline configuration used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the three line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex.

The formal results of the evaluation are reported on the Official EPA forms in Attachment A, B and C of this report.

1.0 Introduction

The federal Environmental Protection Agency (EPA) has provided a series of documents[1] that describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.[2] At the minimum, a leak detector that is capable of detecting leaks of 3.0 gallons per hour (gal/hr) at 10 psi or larger on an hourly basis must be installed on all pressurized pipelines. The probability of detecting a leak of stated size must be 95% or greater with a probability of a false alarm (declaring a tight line to be leaking) of no more than 5%.

This report presents the results of an independent evaluation of the performance of the BFX1V MLLD, when mounted in an STP, for testing on rigid, semi-rigid, flexible and combined pipelines. The evaluation was conducted by Ken Wilcox Associates, Inc. at the Fuels Management Research Center in Grain Valley, Missouri. Testing for this evaluation was performed in accordance with the US EPA protocol "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

A total of 45 tests were conducted to verify that the leak detector could detect 3 gal/hr leaks on Flexible, Rigid and Hybrid pipelines containing unleaded gasoline. The results of this testing indicate that the BFX1V MLLD, when mounted in an STP, for testing on rigid, flexible, and combined pipelines will successfully perform Hourly Testing on Flexible, Rigid and Hybrid pipeline systems.

[1] "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

[2] 40CFR Part 280, Subpart D.

2.0 Overview of Evaluation Procedures

A total of 45 tests were conducted for this evaluation on the BFX1V MLLD, when mounted in an STP. The test conditions for these tests are provided in Table 3. Out of the 45 Hourly tests that were performed, 23 were run with no leak and 22 were run with a leak. Testing was conducted with temperature differentials between the ground and the fuel (that was circulated through the pipeline) at temperature three different temperature differentials including +10, 0 and -10 degrees Fahrenheit.

Testing was carried out using the manufacturer's normal test routine. The BFX1V MLLD, when mounted in an STP, was in the line in its usual configuration. The temperature of the product in the pipeline tank was varied relative to the surrounding soil temperature. Product was then circulated through the line for twice the line volume and leaks were induced at rates equivalent to 3 gal/h at 10 psi for the Hourly testing as specified in the US EPA protocol. Tests were also run with a zero leak rate; that is, with the line in the tight condition. The induced leak rates were established during the circulation period by introducing a controlled flow through a variable cross-sectional area flow meter.

Testing for this evaluation was performed in accordance with the US EPA protocol. The EPA test protocol requires that 21 leak tests, 21 tight tests and 3 tests with vapor present in the line to be conducted, for each of the hourly testing, with various temperature differentials between product in the line and the ground.

Briefly summarized, the test procedures were as follows:

1) Product was conditioned in the pipeline tank to the required temperature. The soil temperature was monitored throughout the entire test at distances of 2, 4, and 12 inches from the pipeline to determine proper temperature differentials.
2) Product was circulated through the pipeline at a rate of approximately 19.7 gal/min for twice the volume of the pipeline (60 minutes).
3) Flow in the line was stopped by closing the outlet valve while the submersible pump was still on. The pump was then turned off and the outlet valve opened to lower the pressure down to zero pressure(less than 1 psi).
4) For a test with a leak to be induced, a pre-calibrated leak was turned on with a leak equivalent to 3 gal/h at 10 psi.
5) The submersible turbine pump dispenser switch was then turned on and the leak detector conducted the test.
6) Steps 1 through 5 were repeated for every set of tests with both tight tests and induced leak tests.

3.0 Description of the Test Equipment

The Veeder-Root BFX1V is a mechanical line leak detector. For this evaluation, the Veeder-Root BFX1V MLLD was mounted in an STP. The BFX1V mechanical line leak detector is designed to be permanently installed in the fuel line, and performs a 3 gal/h hourly test automatically. If a leak is detected by the BFX1V, fuel flow is restricted to the dispensers. The BFX1V sample used in this evaluation had a part # of 410981-001 and serial #107235034. The pictures of the unit evaluated are shown in Image 1 thru 4.

Image 1

Image 2

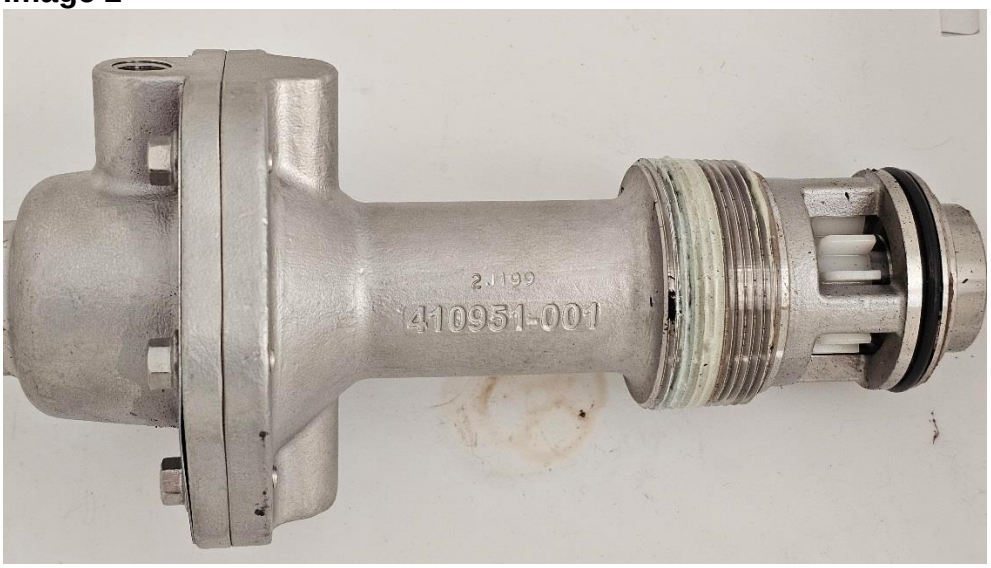


Image 3

Image 4

4.0 Description of the Testing Location

The BFX1V MLLD, when mounted in an STP, was evaluated at the Fuels Management Research Center located in Grain Valley, Missouri, which is operated by Ken Wilcox Associates, Inc. Line tests described in this report were conducted on the combination of pipeline detailed in Table 1. Table 1 shows the pipeline configuration and product used, along with the volumes of the line combination. The bulk modulus, which is a measure of the "stretch" which occurs when the line is pressurized, is shown in Attachment 3. Details of the piping configuration used in the evaluation are included in table 1.

The conditioned product is contained in a 600 gallon steel tank, which is equipped with a standard Red Jacket submersible pump. Product is heated or cooled in the tank by circulating glycol and product through an external heat exchanger. Soil temperatures were monitored using RTDs, which were located at 2 inches, 4 inches and 12 inches from the line as specified by the EPA protocol. A single temperature probe was located 4 inches from the bottom of the product conditioning tank. The weighted soil temperature and the product tank temperature at the beginning of the test were used to compute the temperature differential.

Table 1. Pipeline Configurations Used for Hourly Testing

Segment	Construction	Length (ft)	Diameter (in)	Volume (gal)
1	FRP - single wall	34	3.125	13.55
2	FRP Double wall	200	4	130.38
3	FRP - single wall	40	3.125	16.45
4	Flex -double wall	34	1.5	3.12
5	Flex double wall	130	3.125	51.8
6	FRP - single wall	104	3.125	41.44
7	FRP - single wall	27	3.125	11.1
8	NUPI - TSMAXPD	1964	2	321.5
Total				589.34

Rigid Volume Used (segment 1,2,3,6,7) – 212.92 gallons
Semi-Rigid Volume Used (segment 8) – 321.5 gallons
Flex Volume Used (segment 4,5) – 54.92 gallons
Maximum Volume (2X evaluated) Allowable for Pipeline Testing = 1178.68 gallons
Bulk Modulus of combination line = 17,052 psi

5.0 Test Results and Discussion

The test results of the BFX1V MLLD, when mounted in an STP, were compared to the leak conditions induced in the line. Forty-five hourly tests were conducted using the procedures described in Section 2.0 of this report. For the hourly testing 22 of these tests were run with a 3 gal/h leak induced in the line and 23 were run with the line in the tight condition and 3 of these tests were performed with vapor in the line. During all of the hourly testing, the BFX1V allowed the pipeline to open to full pressure (tight result) with the line in the tight condition and restricted flow (detected leak) during all tests with a 3 gal/hr leak induced. This detected leak or passing test by the BFX1V MLLD was compared to the induced leak or no leak and the results are reported in Appendix B.

Testing was conducted using procedures specified in the US EPA protocol. For the hourly testing, the results of the evaluation have been calculated using Section 5.2 of the US EPA procedures for systems that do not report a leak rate. The results of the data analysis have been summarized in Table 3. The pipeline configuration is described more completely using the EPA Pipeline Protocol Attachment 3 reported as Table 3. The test data for this evaluation are contained in Attachment 4 and 5 and 6, which correspond to Attachments 4, 5 and 6 of the US EPA Protocol.

Calculation of P_{FA} and P_D

Since the BFX1V MLLD hourly tests are a pass/fail system, the calculation of the Probability of Detection (P_D) and the Probability of False Alarm (P_{FA}) was based on the number of correct test results compared to the number of tests of that type. For these standards, the statistics for estimating P_{FA} and P_D were based on the calculations found in Section 5.21 and 5.22 of the pipeline protocol.

Performance for Hourly (3.0 gal/hr) Testing

A total of 45 tests (23 tight and 22 with induced leaks) were conducted for the system. A total of 3 tests (2 tight and 1 with an induced leak) with trapped vapor were conducted for the system. There were no missed detections or false alarms observed for these 45 tests. Forty-five tests were conducted on the system including the three tests with trapped vapor. The P_D and P_{FA} were calculated by dividing the number of correct results by the total number of such tests that were conducted. Since there were no false alarms or missed detections using the hourly test, the estimated P_{FA} was 0% and the estimated P_D was 100%. Since one cannot assume that a qualitative method would never make a mistake only based on about 45 tests, a 95% confidence limit was calculated for each parameter. Based on these calculations, one can be 95% confident that the P_{FA} is between 0% and 12.73%, while the 95% confidence limit for P_D is from 87.79% to 100%. The tests that were performed without a leak induced, ranged from 33 seconds to 69 seconds with an average test time of 49 seconds. The test was determined as tight at the moment when the leak detector opened and allowed full pressure to the pipeline. For each of the tests with a 3 gal/h leak induced, the BFX1V

leak detector restricted the flow to the pipeline and held the pressure at a lower PSI for the full 5 minute duration. After 5 minutes of restricted flow, the test was declared and recorded as a leak result. It is important to note that the 5 minute test time was a KWA selected maximum time to allow for the leak detector to open (passing result) or remain in restricted flow (leak result) for all tests.

Maximum Line Size for Hourly Testing

The EPA allows for line leak detectors to be used on lines up to twice the volume that they were evaluated on. In this evaluation the lines were a total of 2533 feet in length. The volume of the pipeline configuration was 589.34 gallons. The pipeline used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the 3 line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex. Thus, if the EPA allowance is applied to these tests of twice the volume evaluated, the BFX1V MLLD, when mounted in an STP, for hourly testing can be used on lines up to a total volume of 1178.68 gallons.

Waiting Times

Waiting times after the delivery of product, after product is circulated through the line or after pumping has stopped are not necessary before valid tests can be conducted. For the Hourly testing, 2 tests were run after each circulation. As a result, the waiting times for the hourly testing ranged from 0 minutes to 1 minute, with an average of 30 seconds.

Table 3. Performance Parameters for the Veeder-Root BFX1V Mechanical line Leak Detector, Pump Mounted, for Flexible, Rigid, and Hybrid Pipelines Using the EPA Protocol

Parameter	Value
Probability of Detection (P_D) of a 3.0 gal/hr leak (Hourly)	100% (87.79% to 100%)
Probability of False Alarm (Hourly P_{FA})	0% (0% to 12.73%)
Maximum Line Size	Combination of all piping, flexible or rigid or in combination limited to a total capacity of 1178.68 gal. for hourly testing
Waiting Time after Delivery of Product before Conducting a Test	None Required
Waiting Time after Product Circulation Through Line before Conducting a Test	None Required
Hourly Test Times with a 3.0 gal/hr Leak	Range: 5 minutes
Hourly Test Times without Leak	Range: 33 to 69 seconds

6.0 Conclusions

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

- The observed P_D for a 3.0 gal/h leak was 100% and the P_{FA} on a tight line was 0.0%.
- Using the EPA protocol, the BFX1V MLLD, when mounted in an STP, can be used on any pipeline for hourly testing up to 1178.68 gallons in volume including rigid, flexible or a combination of pipeline types.
- A waiting time after product is circulated through the line or after pumping has stopped is not necessary before conducting a valid test.
- A waiting time after delivery of product is not necessary before a valid test can be conducted.

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

Options 1, 2, and 5

Pipeline Leak Detection System for Annual, Monthly and Hourly Testing

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.) [1]	Range from 1.5 in to 4 in*
Length of pipeline (tank to dispenser) (ft) [2]	Rigid – 405ft Semi-Rigid – 1964ft Flex - 164ft **Total Length - 2533 ft**
Volume of product in line during testing (gal) [3]	Rigid – 212.92 gal Semi-Rigid – 321.5 gal Flex – 54.92 gal **Total Volume - 589.34 gal**
Type of material (fiberglass, steel, other[4])	Rigid (FRP), Semi-Rigid and Flex
Type of product in tank and pipeline (gasoline, diesel, other[5])	gasoline
Was a mechanical line leak detector present? (yes or no)	yes
Was trapped vapor present? (yes or no)	Yes(vapor tests only)
Bulk Modulus (B) (psi)	17,052 psi
B/V (psi/ml)	0.0077 psi/ml
Storage tank capacity (gal)	600 gal

[1]Specify for each section of pipe, if different.
[2]Specify length of each section of pipe, if different size or material.
[3]Specify volume for each section of pipe, if different size or type.
[4]Specify type of construction material for each pipe section.
[5]Specify type of product for each tank.

APENDIX A

Hourly (3 gal/h) Results and Attachments

Results Of U.S. EPA Standard Evaluation
Pipeline Release Detection Method

Hourly Test

This form summarizes the results of an evaluation to determine whether the pipeline release detection method named below and described in Attachment 1 complies with the federal UST regulation for conducting an hourly test. The evaluation was conducted according to the U.S. EPA's evaluation procedures, specified in *Standard Test Procedures for Evaluating Release Detection Methods: Pipeline Release Detection*. The full evaluation report includes six attachments.

UST system owners and operators who use this pipeline release detection method should keep this form on file to show compliance with the federal UST regulation. UST system owners and operators should check with state and local regulatory authorities to make sure this form satisfies the requirements of their agencies.

Method Evaluated

Method Name: BFX1V Mechanical Line Leak Detector

Version of Method: BFX1V Mechanical Line Leak Detector, mounted in an STP

Version of System: BFX1V

Manufacturer Name: Veeder-Root

125 Powder Forest Drive
(street address)

Simsbury, CT 06070 (860) 651-2700
(city, state, zip code) (Phone number)

Evaluation Results

1. The performance of this method
   X meets or exceeds
   __ does not meet the federal standards established by the EPA regulation for hourly tests.

   The EPA regulation for an hourly test requires that the method be capable of detecting a leak as small as 3.0 gal/hr 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 3.0 gal/hr defined at a pipeline pressure of 10 psi in this evaluation is 100 %.

Criterion for Declaring a Leak

3. This method
   __uses a preset threshold
   __ measures and reports the output quantity and compares it to a predetermined threshold to determine whether the pipeline is leaking.
   _X_ Other The BFX1V is a mechanical line leak detector. If a 3gal/hr leak is present, the BFX1V will restrict the flow of fuel. If there is no leak present, the leak detector will open up and will allow for the maximum flow of fuel that is produced by the submersible turbine pump.

4. This method
   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 method declares a leak if the output of the measurement method exceeds a threshold of 3.0 gallon per hour (specify flow rate in gal/hr) in 1 out of 1 tests (specify, for example, 1 out of 2, 2 out of 3). Please give additional details, if necessary, in the space provided.

Evaluation Approach

6. A total of 23 tests were conducted on non-leaking tank(s) between 09/14/2023__ (date) and 09/26/2023 (date). A description of the pipeline configuration used in the evaluation is given in Attachment 3.

7. The pipeline used in the evaluation was_between 1.5 and 4_ in. in diameter, 2533ft long and constructed of__rigid(FRP), semi-rigid and flex____(fiberglass, steel, or other).

8. A mechanical line leak detector
   __ was
   X was not present in the pipeline system.

9. The evaluation was conducted on 1 (how many) pipeline systems ranging in diameter from 1.5___ in. to_4_in., ranging in length from_____2533__ft to 2533_____ft, and constructed of__rigid(FRP), semi-rigid and flex_(specify materials).

10. Please specify how much time elapsed between the delivery of product and the start of the data collection:
    X 0 to 6 hr
    __6 to 12 hr
    __12 to 24
    __hr >24 hr

Data Used to Make Performance Estimates

11. The induced leak rate and the test results used to estimate the performance of this method 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

12. _X_ According to the vendor, this method can be used even if trapped vapor is present in the pipeline during a test.
___ According to the vendor, this method *should not be used* if trapped vapor is present in the pipeline.

13. The sensitivity of this method to trapped vapor is indicated by the test results summarized in Table 1. These tests were conducted at 30 psi with 500 mL of vapor trapped in the line at a pressure of 0 psi. The data and test conditions are reported in Attachment 6.

Table 1. Summary of the Results of Trapped Vapor Tests

Test No.	Delta T (deg F)	Induced Leak Rate (gal/h)	Measured Test Result (tight/leak)
43	0.3	0	tight
44	0.3	3	leak
45	0.1	0	tight

Application of the Method

16. This release detection method 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, steel, or other and that typically measure 2 in. in diameter and 150 ft or less in length. The performance estimates are valid when:

- the method that was evaluated has not been substantially changed by subsequent modifications
- the vendor's instructions for using the method are followed
- a 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 hr
- the waiting time between the last dispensing of product through the pipeline system and the start of data collection for the test is 0 hr
- the total data collection time for the test is between 33 seconds and 5 minutes
- the volume of the product in the pipeline system is less than twice the volume of the product in the pipeline system used in the evaluation, unless a separate written justification for testing larger pipeline systems is presented by the vendor, concurred with by the evaluator, and included with this evaluation as an additional attachment.
- give any other limitations specified by the vendor or determined during the evaluation: _____

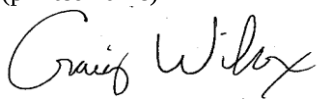
Attachments

Attachment 1 - Description of the Method Evaluated
Attachment 2 - Summary of the Performance of the Method 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

Certification of Results

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

Craig Wilcox
(printed name)



(signature)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Grain Valley, Missouri 64029
(city, state, zip)

November 10, 2023
(date)

(816) 443-2494
(phone number)

Attachment 1
Description

Pipeline Release Detection Method

The evaluator, with help from the vendor, fills out this form prior to the start of the evaluation. This form provides a description of the method and how it works. It should be filled out completely – check all appropriate boxes for each question. If *other* is checked, provide a description. For those answers dependent on site conditions, give answers that apply in typical conditions. This form is to be filled out by the evaluator with assistance from the vendor before the start of the evaluation. Describe the important features of the method as indicated below. A detailed description is not required, nor is it necessary to reveal proprietary features of the system.

Method Name and Version: _____

Date: _____

Applicability of the Method

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

   X gasoline
   __diesel
   __aviation fuel
   __fuel oil #4
   __fuel oil #6
   __solvent
   __waste oil
   __ other (specify) _____

2. What types of pipelines can be tested? (Check all applicable responses.)
   X fiberglass
   X steel
   X other (specify) This system can be used on any pipeline type including rigid, flex and semi-rigid

3. Can this release detection method be used to test double-wall pipeline systems?
   X yes(primary pipe) ☐ no

4. What is the nominal diameter of a pipeline that can be tested with this method?
   __1 in. or less
   X between 1 and 3 in.
   X between 3 and 6 in.
   __between 6 and 10 in.
   other _____

5. The method can be used on pipelines pressurized to _50_ psi

   The safe maximum operating pressure for this method is _50___ psi.

6. Does the method conduct a test while a mechanical line leak detector is in place in the pipeline?
   X Not applicable - The BFX1V is a mechanical line leak detector

General Features of the Method

7. What type of test is the method conducting? (Check all applicable responses.)
   __0.10 gal/hr Line Tightness Test
   __0.20 gal/hr Monthly Monitoring
   X_ 3 gal/hr Hourly

8. Is the method permanently installed on the pipeline?
   X yes ☐ no

   Does the method test the line automatically?
   X yes ☐ no

If a leak is declared, what does the method do? (Check all applicable responses.)
__ displays or prints a message
__ triggers an alarm
__ programmable alerts via Ethernet, serial, SMS, email-mail or internet
X Restricts the flow of fuel and does not allow for full pressure on the line past the leak detector

9. What quantity or quantities are measured by the method? (Please list.)

   This leak detector is a mechanical line leak detector. The leak detector detects if there is a 3 gal/hr or greater leak in the pipeline beyond the point where the leak detector installed.

10. Does the method 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 method 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?
    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 release detection test?
    X no waiting
    __period less than 15
    __min 15 min to 1 hr
    __1 to 5 hr
    __6 to 12 hr
    __12 to 24 hr greater
    __than 24 hr
    __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 release detection test?

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

15. What is the minimum amount of time necessary to set up equipment and complete a release 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.)

The test duration for this evaluation ranged from 33 seconds to 69 seconds for a tight test and 5 minutes for a test with a leak. The average time for a tight test was 49 seconds for the MLLD to open(pass) on a 589.34 gallon line as evaluated. For tests with a leak induced, the test duration was 5 minutes. The BFX1V MLLD remained in the restricted flow(leak detected) for the full duration of the 5 minute test (single test).

not applicable hr (multiple test)

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

_ yes 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?

X no ☐ yes___

_____

_____

If yes, briefly specify:

21. Are elements of the test procedures determined by on-site testing 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
X other (Describe briefly.) _____

Data Acquisition

22. How are the test data acquired and recorded?

__ manually
__ by strip
__chart by
__computer
X This is a mechanical line leak detector, no data is acquired or recorded

23. Certain calculations are necessary to reduce and analyze the data. How are these calculations done?
__ manual calculations by the evaluator on site
__interactive computer program used by the
__automatically done with computer program
X This is a mechanical line leak detector, no data is acquired or recorded

Detection Criterion

24. What threshold is used to determine whether the pipeline is leaking?
Not applicable – this is an MLLD (in the units used by the measurement system)
Not applicable – this is an MLLD (in gal/hr)

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 3 questions below)

X no

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?
X never
__before each test
__weekly monthly
__semi-annually
__yearly or less frequently

Attachment 2
Summary Of Performance Estimates

Pipeline Release Detection Method
Hourly Test
First Test Of A Multiple-Test Sequence

Complete this page only if the method being evaluated requires, as part of its test procedures, more than one complete test to determine whether the pipeline is leaking. Method performance based on the first test alone must be reported on this form. Complete the first table. The last three tables present the performance of the method for different combinations of thresholds, probabilities of false alarm, and probabilities of detection. They are useful for comparing the performance of this method to that of other methods. However, completion of the last three tables is optional.

Performance Of The Pipeline Release Detection Method As Evaluated

Description	Leak Rate (gal/hr)	P(d)	P(fa)	Threshold (gal/hr)
Evaluated Method	3.0	100%	0%	N/A
EPA Standard	3.0	0.95	0.05	N/A

P(fa) As A Function Of Threshold

Threshold (gal/hr)	P(fa)
	0.10
	0.075
	0.05
	0.05

P(d) As A Function Of Threshold For A Leak Rate Of 3.0 gal/hr

Threshold (gal/hr)	P(d)
	0.95
	0.90
	0.80
	0.50

Smallest Leak Rate That Can Be Detected With The Specified P(d) and P(fa)

Leak Rate (gal/hr)	P(d)	P(fa)
	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)

Complete these tables to identify the configuration of the pipeline system.

Pipeline Release Detection Method At Test Facility Or Retail Station

Specialized Test Facility Or Operational UST Facility	
Inside diameter of pipeline (in.)	1.5" to 4"
Length of pipeline (tank to dispenser) (ft)	2533'
Volume of product in line during testing (gal)	589.34
Type of material (fiberglass, steel, other*)	Fiberglass, Flex and Semi-Rigid
Type of product in tank and pipeline (gasoline, diesel, other**)	gasoline
Was a mechanical line leak detector present? (yes or no)	No
Was trapped vapor present? (yes or no)	No
Compressibility (C) (psi)	17,052
C/Vo (psi/gal)	0.0077 psi/ml
Storage tank capacity (gal)	600

* Specify type of construction material.

Attachment 4
Hourly(3 gal/h) Tests
Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation
Veeder-Root BFX1V Pump Mounted - Unleaded
Pipeline Leak Detection Systems
Options 1 and 5

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
1	9/14/2023	74.9	1178.68	60 min	1400	1300	74.9	74.9	74.9	74.9	74.9	0.0	neutral
2	9/14/2023	74.9	1178.68	60 min	1400	1300	74.9	74.9	74.9	74.9	74.9	0.0	neutral
3	9/18/2023	74.9	1178.68	60 min	1109	1009	74.9	74.0	74.0	74.0	74.0	0.9	neutral
4	9/18/2023	74.9	1178.68	60 min	1109	1009	74.9	74.0	74.0	74.0	74.0	0.9	neutral
5	9/18/2023	58.3	1178.68	60 min	1328	1228	58.3	74.2	74.2	74.1	74.1	-15.8	< -10 deg
6	9/18/2023	58.3	1178.68	60 min	1328	1228	58.3	74.2	74.2	74.1	74.1	-15.8	< -10 deg
7	9/18/2023	63.5	1178.68	60 min	1452	1352	63.5	72.8	73.6	74.2	73.9	-10.4	< -10 deg
8	9/18/2023	63.5	1178.68	60 min	1452	1352	63.5	72.8	73.6	74.2	73.9	-10.4	< -10 deg
9	9/18/2023	61.3	1178.68	60 min	1605	1505	61.3	72.3	73.5	74.1	73.8	-12.5	< -10 deg
10	9/18/2023	61.3	1178.68	60 min	1605	1505	61.3	72.3	73.5	74.1	73.8	-12.5	< -10 deg
11	9/18/2023	63.6	1178.68	60 min	1725	1625	63.6	72.0	73.3	74.1	73.7	-10.1	< -10 deg
12	9/18/2023	63.6	1178.68	60 min	1725	1625	63.6	72.0	73.3	74.1	73.7	-10.1	< -10 deg
13	9/18/2023	63.4	1178.68	60 min	1930	1830	63.4	71.9	73.2	74.0	73.6	-10.2	< -10 deg
14	9/18/2023	63.4	1178.68	60 min	1930	1830	63.4	71.9	73.2	74.0	73.6	-10.2	< -10 deg
15	9/18/2023	63.0	1178.68	60 min	2113	2030	63.0	71.7	73.1	73.9	73.5	-10.5	< -10 deg
16	9/18/2023	63.0	1178.68	60 min	2113	2030	63.0	71.7	73.1	73.9	73.5	-10.5	< -10 deg
17	9/19/2023	58.5	1178.68	60 min	1553	1453	58.5	72.5	72.9	73.4	73.2	-14.7	< -10 deg
18	9/19/2023	58.5	1178.68	60 min	1553	1453	58.5	72.5	72.9	73.4	73.2	-14.7	< -10 deg
19	9/19/2023	70.1	1178.68	60 min	1720	1620	70.1	71.7	72.8	73.4	73.1	-3.0	neutral
20	9/19/2023	70.1	1178.68	60 min	1720	1620	70.1	71.7	72.8	73.4	73.1	-3.0	neutral
21	9/20/2023	88.5	1178.68	60 min	1900	1800	88.5	73.2	73.3	73.5	73.4	15.1	>+10

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category	
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)	
22	9/20/2023	88.5	1178.68	60 min	1900	1800	88.5	73.2	73.3	73.5	73.4	15.1	>+10	
23	9/21/2023	84.3	1178.68	60 min	2021	1921	84.3	74.6	73.8	73.5	73.7	10.6	>+10	
24	9/21/2023	84.3	1178.68	60 min	2021	1921	84.3	74.6	73.8	73.5	73.7	10.6	>+10	
25	9/21/2023	84.3	1178.68	60 min	1549	1449	84.3	74.2	74.0	74.0	74.0	10.3	>+10	
26	9/21/2023	84.3	1178.68	60 min	1549	1449	84.3	74.2	74.0	74.0	74.0	10.3	>+10	
27	9/21/2023	84.5	1178.68	60 min	1745	1645	84.5	75.4	74.5	74.1	74.3	10.2	>+10	
28	9/21/2023	84.5	1178.68	60 min	1745	1645	84.5	75.4	74.5	74.1	74.3	10.2	>+10	
29	9/21/2023	84.8	1178.68	60 min	1909	1809	84.8	76.3	74.7	74.2	74.5	10.3	>+10	
30	9/21/2023	84.8	1178.68	60 min	1909	1809	84.8	76.3	74.7	74.2	74.5	10.3	>+10	
31	9/22/2023	74.8	1178.68	60 min	1350	1250	74.8	74.5	74.4	74.3	74.3	0.5	neutral	
32	9/22/2023	74.8	1178.68	60 min	1350	1250	74.8	74.5	74.4	74.3	74.3	0.5	neutral	
33	9/22/2023	85.8	1178.68	60 min	1512	1412	85.8	74.5	74.4	74.3	74.3	11.5	>+10	
34	9/22/2023	85.8	1178.68	60 min	1512	1412	85.8	74.5	74.4	74.3	74.3	11.5	>+10	
35	9/22/2023	84.8	1178.68	60 min	1626	1526	84.8	75.7	74.5	74.3	74.5	10.3	>+10	
36	9/22/2023	84.8	1178.68	60 min	1626	1526	84.8	75.7	74.5	74.3	74.5	10.3	>+10	
37	9/22/2023	75.1	1178.68	60 min	1750	1650	75.1	75.9	75.0	74.5	74.8	0.3	neutral	
38	9/22/2023	75.1	1178.68	60 min	1750	1650	75.1	75.9	75.0	74.5	74.8	0.3	neutral	
39	9/24/2023	74.0	1178.68	60 min	1850	1750	74.0	73.9	73.9	73.9	73.9	0.1	neutral	
40	9/24/2023	74.0	1178.68	60 min	1850	1750	74.0	73.9	73.9	73.9	73.9	0.1	neutral	
41	9/25/2023	73.7	1178.68	60 min	1402	1302	73.7	73.5	73.5	73.5	73.5	0.2	neutral	
42	9/25/2023	73.7	1178.68	60 min	1402	1302	73.7	73.5	73.5	73.5	73.5	0.2	neutral	
43	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral	vapor
44	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral	vapor
45	9/26/2023	73.6	1178.68	60 min	1528	1428	73.6	73.6	73.5	73.5	73.5	0.1	neutral	vapor

Attachment 5

Hourly (3gal/h)

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

Veeder-Root BFX1V Pump Mounted - Unleaded

Pipeline Release Detection Method *At a Test Facility*

Test No. (Based on Temperature Condition	Date Test Began	Induced Leak Rate	Time Circulation Ended	Time Between End of of Circulation and Start of Data Collection for Test	Time Data Collection Began	Time Data Collection Ended	Measured Test Result	Was Threshold Exceeded?	Test Duration for leak result tests	Test Duration for tight result tests	
	(D-M-Y)	(gal/hr)	(military)	(min)	(military)	(military)	(leak or tight)	(yes or no)	(seconds)	(seconds)	
1	9/14/2023	0	1400	0	1400	1401	tight	no		63	
2	9/14/2023	3	1400	1	1401	1406	leak	yes	300		
3	9/18/2023	0	1109	0	1109	1110	tight	no		63	
4	9/18/2023	3	1109	1	1110	1115	leak	yes	300		
5	9/18/2023	0	1328	0	1328	1329	tight	no		37	
6	9/18/2023	3	1328	1	1329	1334	leak	yes	300		
7	9/18/2023	0	1452	0	1452	1453	tight	no		50	
8	9/18/2023	3	1452	1	1453	1458	leak	yes	300		
9	9/18/2023	0	1605	0	1605	1606	tight	no		41	
10	9/18/2023	3	1605	1	1606	1611	leak	yes	300		
11	9/18/2023	0	1725	0	1725	1726	tight	no		69	
12	9/18/2023	3	1725	1	1726	1731	leak	yes	300		
13	9/18/2023	0	1930	0	1930	1931	tight	no		57	
14	9/18/2023	3	1930	1	1931	1936	leak	yes	300		
15	9/18/2023	0	2113	0	2113	2114	tight	no		42	
16	9/18/2023	3	2113	1	2114	2119	leak	yes	300		
17	9/19/2023	0	1553	0	1553	1554	tight	no		38	
18	9/19/2023	3	1553	1	1554	1559	leak	yes	300		
19	9/19/2023	0	1720	0	1720	1721	tight	no		52	
20	9/19/2023	3	1720	1	1721	1726	leak	yes	300		
21	9/20/2023	0	1900	0	1900	1901	tight	no		58	
22	9/20/2023	3	1900	1	1901	1906	leak	yes	300		
23	9/21/2023	0	2021	0	2021	2022	tight	no		54	
24	9/21/2023	3	2021	1	2022	2027	leak	yes	300		
25	9/21/2023	0	1549	0	1549	1550	tight	no		53	
26	9/21/2023	3	1549	1	1550	1555	leak	yes	300		
27	9/21/2023	0	1745	0	1745	1746	tight	no		63	
28	9/21/2023	3	1745	1	1746	1751	leak	yes	300		
29	9/21/2023	0	1909	0	1909	1910	tight	no		40	
30	9/21/2023	3	1909	1	1910	1915	leak	yes	300		
31	9/22/2023	0	1350	0	1350	1351	tight	no		53	
32	9/22/2023	3	1350	1	1351	1356	leak	yes	300		
33	9/22/2023	0	1512	0	1512	1513	tight	no		59	
34	9/22/2023	3	1512	1	1513	1518	leak	yes	300		
35	9/22/2023	0	1626	0	1626	1627	tight	no		43	
36	9/22/2023	3	1626	1	1627	1632	leak	yes	300		
37	9/22/2023	0	1750	0	1750	1751	tight	no		53	
38	9/22/2023	3	1750	1	1751	1756	leak	yes	300		
39	9/24/2023	0	1850	0	1850	1851	tight	no		34	
40	9/24/2023	3	1850	1	1851	1856	leak	yes	300		
41	9/25/2023	0	1402	0	1402	1403	tight	no		33	
42	9/25/2023	3	1402	1	1403	1408	leak	yes	300		
43	9/26/2023	0	1405	0	1405	1406	tight	no		33	vapor
44	9/26/2023	3	1405	1	1406	1411	leak	yes	300		vapor
45	9/26/2023	0	1528	0	1528	1529	tight	no		43	vapor

Attachment 6

Hourly (3.0 gal/hr)

Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Veeder-Root BFX1V Pump Mounted - Unleaded

Pipeline Leak Detection System

Options 1 and 5

Summary of Temperature Conditions

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
43	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral
44	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral
45	9/26/2023	73.6	1178.68	60 min	1528	1428	73.6	73.6	73.5	73.5	73.5	0.1	neutral

Summary of Leak Rates

Test No.	Date Test Began	Pipeline Pressure	Induced Leak Rate	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-min)	(local military)	(local military)	(Tight or Leak)	(Yes or No)
43	9/26/2023	30	0	0	1405	1406	Tight	No
44	9/26/2023	30	3	1	1406	1411	Leak	Yes
45	9/26/2023	30	0	0	1528	1529	Tight	No

Evaluation of the Veeder-Root BFX1V Mechanical Pipeline Leak Detector, BFVD Manifold Mounted, for Hourly Testing on Rigid, Flexible and Hybrid Pipelines

Final Report Version 1

PREPARED FOR

Veeder-Root
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November 12, 2023

Preface

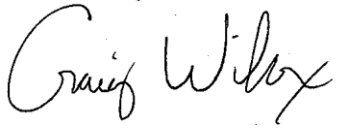
This report was prepared for Veeder-Root by Ken Wilcox Associates, Inc. This report presents the results of an independent performance evaluation of the Veeder-Root BFX1V Mechanical Pipeline Leak Detector(MLLD) Mounted in a Veeder-Root Big Flow Valve Diaphragm (BFVD) Manifold for use on rigid, flexible, and combined pipelines.

This report covers the performance of the BFX1V MLLD when mounted in the BFVD manifold for Hourly (3gph) testing for pressurized piping. The purpose of the current testing is to show that the system performs adequately when tested on rigid, flexible as well as hybrid piping. Testing for this evaluation was performed in accordance with the US EPA protocol “Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection”, May 2019. The results indicate that the BFX1V MLLD when mounted in the BFVD manifold will successfully detect a leak of 3gph on flexible, rigid and hybrid pipeline systems.

The work was conducted at the Fuels Management Research Center, which is operated by Ken Wilcox Associates, Inc. This report was prepared by Craig D Wilcox for, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to the Veeder-Root Engineering Department at 860-651-2700.

November 12, 2023 KEN WILCOX ASSOCIATES, INC.

Approved:



Craig D Wilcox
President

Table of Contents

Executive Summary

This report presents the results of an independent evaluation of the BFX1V MLLD when mounted in the BFVD manifold for hourly testing on flexible, rigid and combination pipelines. The test procedures used were those described in the US EPA protocol "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

The performance capabilities of the BFX1V MLLD when mounted in the BFVD manifold were determined for Hourly Testing. The BFX1V MLLD when mounted in the BFVD manifold met the US EPA performance standards for hourly pipeline leak detection systems which require a probability of detecting a leak of stated size be 95% or greater with a probability of false alarm (declaring a tight line to be leaking) of no more than 5%.

The BFX1V MLLD when mounted in the BFVD manifold was tested on a pipeline consisting of rigid, semi-rigid and flexible pipe. The total line volume for hourly testing was 589.34 gallons of unleaded gasoline with a bulk modulus of 17,052 psi. The pipeline configuration used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the three line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex.

The formal results of the evaluation are reported on the Official EPA forms in Attachment A, B and C of this report.

1.0 Introduction

The federal Environmental Protection Agency (EPA) has provided a series of documents[1] that describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.[2] At the minimum, a leak detector that is capable of detecting leaks of 3.0 gallons per hour (gal/hr) at 10 psi or larger on an hourly basis must be installed on all pressurized pipelines. The probability of detecting a leak of stated size must be 95% or greater with a probability of a false alarm (declaring a tight line to be leaking) of no more than 5%.

This report presents the results of an independent evaluation of the performance of the BFX1V MLLD when mounted in the BFVD manifold for testing on rigid, semi-rigid, flexible and combined pipelines. The evaluation was conducted by Ken Wilcox Associates, Inc. at the Fuels Management Research Center in Grain Valley, Missouri. Testing for this evaluation was performed in accordance with the US EPA protocol "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

A total of 45 tests were conducted to verify that the leak detector could detect 3 gal/hr leaks on Flexible, Rigid and Hybrid pipelines containing unleaded gasoline. The results of this testing indicate that the BFX1V MLLD when mounted in the BFVD manifold for testing on rigid, flexible, and combined pipelines will successfully perform Hourly Testing on Flexible, Rigid and Hybrid pipeline systems.

[1] "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

[2] 40CFR Part 280, Subpart D.

2.0 Overview of Evaluation Procedures

A total of 45 tests were conducted for this evaluation on the BFX1V MLLD when mounted in the BFVD manifold. The test conditions for these tests are provided in Table 3. Out of the 45 Hourly tests that were performed, 23 were run with no leak and 22 were run with a leak. Testing was conducted with temperature differentials between the ground and the fuel (that was circulated through the pipeline) at temperature three different temperature differentials including +10, 0 and -10 degrees Fahrenheit.

Testing was carried out using the manufacturer's normal test routine. The BFX1V MLLD when mounted in the BFVD manifold was in the line in its usual configuration. The temperature of the product in the pipeline tank was varied relative to the surrounding soil temperature. Product was then circulated through the line for twice the line volume and leaks were induced at rates equivalent to 3 gal/h at 10 psi for the Hourly testing as specified in the US EPA protocol. Tests were also run with a zero leak rate; that is, with the line in the tight condition. The induced leak rates were established during the circulation period by introducing a controlled flow through a variable cross-sectional area flow meter.

Testing for this evaluation was performed in accordance with the US EPA protocol. The EPA test protocol requires that 21 leak tests, 21 tight tests and 3 tests with vapor present in the line to be conducted, for each of the hourly testing, with various temperature differentials between product in the line and the ground.

Briefly summarized, the test procedures were as follows:

1) Product was conditioned in the pipeline tank to the required temperature. The soil temperature was monitored throughout the entire test at distances of 2, 4, and 12 inches from the pipeline to determine proper temperature differentials.
2) Product was circulated through the pipeline at a rate of approximately 19.7 gal/min for twice the volume of the pipeline (60 minutes).
3) Flow in the line was stopped by closing the outlet valve while the submersible pump was still on. The pump was then turned off and the outlet valve opened to lower the pressure down to zero pressure(less than 1 psi).
4) For a test with a leak to be induced, a pre-calibrated leak was turned on with a leak equivalent to 3 gal/h at 10 psi.
5) The submersible turbine pump dispenser switch was then turned on and the leak detector conducted the test.
6) Steps 1 through 5 were repeated for every set of tests with both tight tests and induced leak tests.

3.0 Description of the Test Equipment

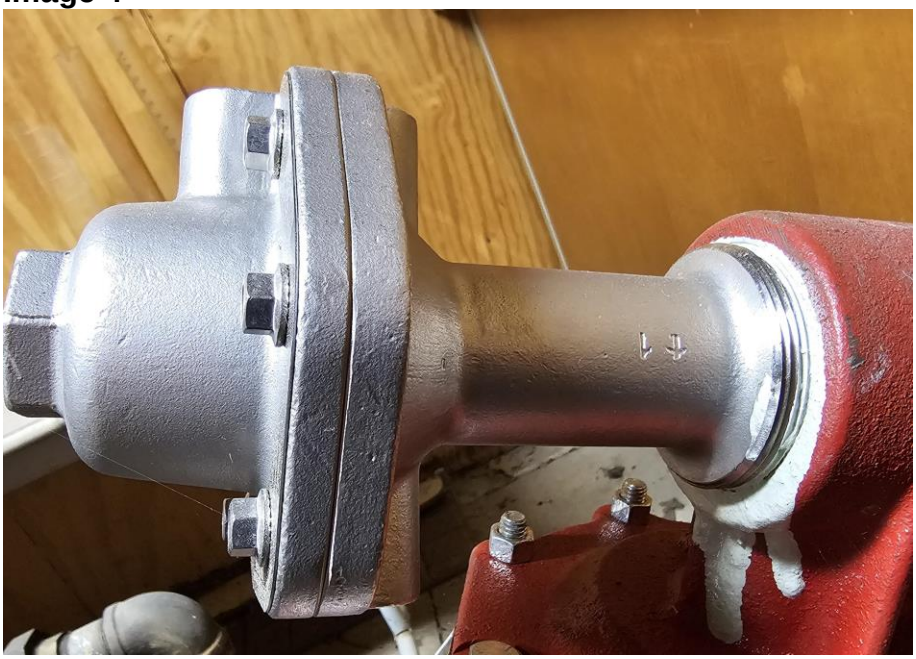
The Veeder-Root BFX1V is a mechanical line leak detector. For this evaluation, the Veeder-Root BFX1V was mounted in a BFVD manifold rather than a submersible turbine pump (STP). The BFX1V mechanical line leak detector is designed to be permanently installed in the fuel line, and performs a 3 gal/h hourly test automatically. If a leak is detected by the BFX1V, fuel flow is restricted to the dispensers. The BFX1V sample used in this evaluation had a part #410981-001 and a serial #107235033. The pictures of the unit evaluated are shown in Image 1 thru 4.

Image 1

Image 2

Image 3

Image 4



4.0 Description of the Testing Location

The BFX1V MLLD, mounted in the BFVD manifold, was evaluated at the Fuels Management Research Center located in Grain Valley, Missouri, which is operated by Ken Wilcox Associates, Inc. Line tests described in this report were conducted on the combination of pipeline detailed in Table 1. Table 1 shows the pipeline configuration and product used, along with the volumes of the line combination. The bulk modulus, which is a measure of the "stretch" which occurs when the line is pressurized, is shown in Attachment 3. Details of the piping configuration used in the evaluation are included in table 1.

The conditioned product is contained in a 600 gallon steel tank, which is equipped with a standard Red Jacket submersible pump. Product is heated or cooled in the tank by circulating glycol and product through an external heat exchanger. Soil temperatures were monitored using RTDs, which were located at 2 inches, 4 inches and 12 inches from the line as specified by the EPA protocol. A single temperature probe was located 4 inches from the bottom of the product conditioning tank. The weighted soil temperature and the product tank temperature at the beginning of the test were used to compute the temperature differential.

Table 1. Pipeline Configurations Used for Hourly Testing

Segment	Construction	Length (ft)	Diameter (in)	Volume (gal)
1	FRP - single wall	34	3.125	13.55
2	FRP Double wall	200	4	130.38
3	FRP - single wall	40	3.125	16.45
4	Flex -double wall	34	1.5	3.12
5	Flex double wall	130	3.125	51.8
6	FRP - single wall	104	3.125	41.44
7	FRP - single wall	27	3.125	11.1
8	NUPI - TSMAXPD	1964	2	321.5
Total				589.34

Rigid Volume Used (segment 1,2,3,6,7) – 212.92 gallons
Semi-Rigid Volume Used (segment 8) – 321.5 gallons
Flex Volume Used (segment 4,5) – 54.92 gallons
Maximum Volume (2X evaluated) Allowable for Pipeline Testing = 1178.68 gallons
Bulk Modulus of combination line = 17,052 psi

5.0 Test Results and Discussion

The test results of the BFX1V MLLD when mounted in the BFVD manifold were compared to the leak conditions induced in the line. Forty-five hourly tests were conducted using the procedures described in Section 2.0 of this report. For the hourly testing 22 of these tests were run with a 3 gal/h leak induced in the line and 23 were run with the line in the tight condition and 3 of these tests were performed with vapor in the line. During all of the hourly testing, the BFX1V allowed the pipeline to open to full pressure (tight result) with the line in the tight condition and restricted flow (detected leak) during all tests with a 3 gal/hr leak induced. This detected leak or passing test by the BFX1V MLLD was compared to the induced leak or no leak and the results are reported in Appendix B.

Testing was conducted using procedures specified in the US EPA protocol. For the hourly testing, the results of the evaluation have been calculated using Section 5.2 of the US EPA procedures for systems that do not report a leak rate. The results of the data analysis have been summarized in Table 3. The pipeline configuration is described more completely using the EPA Pipeline Protocol Attachment 3 reported as Table 3. The test data for this evaluation are contained in Attachment 4 and 5 and 6, which correspond to Attachments 4, 5 and 6 of the US EPA Protocol.

Calculation of P_{FA} and P_D

Since the BFX1V MLLD hourly tests are a pass/fail system, the calculation of the Probability of Detection (P_D) and the Probability of False Alarm (P_{FA}) was based on the number of correct test results compared to the number of tests of that type. For these standards, the statistics for estimating P_{FA} and P_D were based on the calculations found in Section 5.21 and 5.22 of the pipeline protocol.

Performance for Hourly (3.0 gal/hr) Testing

A total of 45 tests (23 tight and 22 with induced leaks) were conducted for the system. A total of 3 tests (2 tight and 1 with an induced leak) with trapped vapor were conducted for the system. There were no missed detections or false alarms observed for these 45 tests. Forty-five tests were conducted on the system including the three tests with trapped vapor. The P_D and P_{FA} were calculated by dividing the number of correct results by the total number of such tests that were conducted. Since there were no false alarms or missed detections using the hourly test, the estimated P_{FA} was 0% and the estimated P_D was 100%. Since one cannot assume that a qualitative method would never make a mistake only based on about 45 tests, a 95% confidence limit was calculated for each parameter. Based on these calculations, one can be 95% confident that the P_{FA} is between 0% and 12.73%, while the 95% confidence limit for P_D is from 87.79% to 100%. The tests that were performed without a leak induced, ranged from 37 seconds to 65 seconds with an average test time of 50 seconds. The test was determined as tight at the moment when the leak detector opened and allowed full pressure to the pipeline. For each of the tests with a 3 gal/h leak induced, the BFX1V

leak detector restricted the flow to the pipeline and held the pressure at a lower PSI for the full 5 minute duration. After 5 minutes of restricted flow, the test was declared and recorded as a leak result. It is important to note that the 5 minute test time was a KWA selected maximum time to allow for the leak detector to open (passing result) or remain in restricted flow (leak result) for all tests.

Maximum Line Size for Hourly Testing

The EPA allows for line leak detectors to be used on lines up to twice the volume that they were evaluated on. In this evaluation the lines were a total of 2533 feet in length. The volume of the line configuration was 589.34 gallons. The pipeline used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the 3 line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex. Thus, if the EPA allowance is applied to these tests of twice the volume evaluated, the BFX1V MLLD, when mounted in an STP, for hourly testing can be used on lines up to a total volume of 1178.68 gallons.

Waiting Times

Waiting times after the delivery of product, after product is circulated through the line or after pumping has stopped are not necessary before valid tests can be conducted. For the Hourly testing, 2 tests were run after each circulation. As a result, the waiting times for the hourly testing ranged from 0 to 7 minutes, with an average of 6 minutes 23 seconds.

Table 3. Performance Parameters for the Veeder-Root BFX1V Mechanical line Leak Detector with BFVD manifold for Flexible, Rigid, and Hybrid Pipelines Using the EPA Protocol

Parameter	Value
Probability of Detection (P_D) of a 3.0 gal/hr leak (Hourly)	100% (87.79% to 100%)
Probability of False Alarm (Hourly P_{FA})	0% (0% to 12.73%)
Maximum Line Size	Combination of all piping, flexible or rigid or in combination limited to a total capacity of 1178.68 gal. for hourly testing
Waiting Time after Delivery of Product before Conducting a Test	None Required
Waiting Time after Product Circulation Through Line before Conducting a Test	None Required
Hourly Test Times with a 3.0 gal/hr Leak	Range: 5 minutes
Hourly Test Times without Leak	Range: 37 to 65 seconds

6.0 Conclusions

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

- The observed P_D for a 3.0 gal/h leak was 100% and the P_{FA} on a tight line was 0.0%.
- Using the EPA protocol, the BFX1V MLLD, when mounted in the BFVD manifold, can be used on any pipeline for hourly testing up to 1178.68 gallons in volume including rigid, flexible or a combination of pipeline types.
- A waiting time after product is circulated through the line or after pumping has stopped is not necessary before conducting a valid test.
- A waiting time after delivery of product is not necessary before a valid test can be conducted.

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

Options 1, 2, and 5

Pipeline Leak Detection System for Annual, Monthly and Hourly Testing

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.) [1]	Range from 1.5 in to 4 in*
Length of pipeline (tank to dispenser) (ft) [2]	Rigid – 405ft Semi-Rigid – 1964ft Flex - 164ft **Total Length - 2533 ft**
Volume of product in line during testing (gal) [3]	Rigid – 212.92 gal Semi-Rigid – 321.5 gal Flex – 54.92 gal **Total Volume - 589.34 gal**
Type of material (fiberglass, steel, other[4])	Rigid (FRP), Semi-Rigid and Flex
Type of product in tank and pipeline (gasoline, diesel, other[5])	Unleaded Gasoline
Was a mechanical line leak detector present? (yes or no)	No
Was trapped vapor present? (yes or no)	yes
Bulk Modulus (B) (psi)	17,052 psi
B/V (psi/ml)	0.0077 psi/ml
Storage tank capacity (gal)	600 gal

[1]Specify for each section of pipe, if different.
[2]Specify length of each section of pipe, if different size or material.
[3]Specify volume for each section of pipe, if different size or type.
[4]Specify type of construction material for each pipe section.
[5]Specify type of product for each tank.

APENDIX A

Hourly (3 gal/h) Results and Attachments

Results Of U.S. EPA Standard Evaluation
Pipeline Release Detection Method

Hourly Test

This form summarizes the results of an evaluation to determine whether the pipeline release detection method named below and described in Attachment 1 complies with the federal UST regulation for conducting an hourly test. The evaluation was conducted according to the U.S. EPA's evaluation procedures, specified in *Standard Test Procedures for Evaluating Release Detection Methods: Pipeline Release Detection*. The full evaluation report includes six attachments.

UST system owners and operators who use this pipeline release detection method should keep this form on file to show compliance with the federal UST regulation. UST system owners and operators should check with state and local regulatory authorities to make sure this form satisfies the requirements of their agencies.

Method Evaluated

Method Name: BFX1V Mechanical Line Leak Detector

Version of Method: BFX1V MLLD when mounted in the BFVD manifold

Version of System: BFX1V

Manufacturer Name: Veeder-Root

125 Powder Forest Drive
(street address)

Simsbury, CT 06070 (860) 651-2700
(city, state, zip code) (Phone number)

Evaluation Results

1. The performance of this method
   X meets or exceeds
   __ does not meet the federal standards established by the EPA regulation for hourly tests.

   The EPA regulation for an hourly test requires that the method be capable of detecting a leak as small as 3.0 gal/hr 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 3.0 gal/hr defined at a pipeline pressure of 10 psi in this evaluation is 100 %.

Criterion for Declaring a Leak

3. This method
   __uses a preset threshold
   __ measures and reports the output quantity and compares it to a predetermined threshold to determine whether the pipeline is leaking.
   _X_ Other The BFX1V is a mechanical line leak detector. If a 3gal/hr leak is present, the BFX1V will restrict the flow of fuel. If there is no leak present, the leak detector will open up and will allow for the maximum flow of fuel that is produced by the submersible turbine pump.

4. This method
   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 method declares a leak if the output of the measurement method exceeds a threshold of 3.0 gallon per hour (specify flow rate in gal/hr) in 1 out of 1 tests (specify, for example, 1 out of 2, 2 out of 3). Please give additional details, if necessary, in the space provided.

Evaluation Approach

6. A total of 23 tests were conducted on non-leaking tank(s) between 09/14/2023 ___(date) and 09/26/2023___ (date). A description of the pipeline configuration used in the evaluation is given in Attachment 3.

7. The pipeline used in the evaluation was_between 1.5 and 4_in. in diameter, 2533ft long and constructed of__rigid(FRP), semi-rigid and flex____(fiberglass, steel, or other).

8. A mechanical line leak detector
   __ was
   X was not present in the pipeline system.

9. The evaluation was conducted on 1 (how many) pipeline systems ranging in diameter from 1.5___ in. to_4_in., ranging in length from_____2533__ft to 2533_____ft, and constructed of_rigid(FRP), semi-rigid and flex_(specify materials).

10. Please specify how much time elapsed between the delivery of product and the start of the data collection:
    X 0 to 6 hr
    __6 to 12 hr
    __12 to 24
    __hr >24 hr

Data Used to Make Performance Estimates

11. The induced leak rate and the test results used to estimate the performance of this method 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

12. _X_ According to the vendor, this method can be used even if trapped vapor is present in the pipeline during a test.
___ According to the vendor, this method *should not be used* if trapped vapor is present in the pipeline.

13. The sensitivity of this method to trapped vapor is indicated by the test results summarized in Table 1. These tests were conducted at 30 psi with 500 mL of vapor trapped in the line at a pressure of 0 psi. The data and test conditions are reported in Attachment 6.

Table 1. Summary of the Results of Trapped Vapor Tests

Test No.	Delta T (deg F)	Induced Leak Rate (gal/h)	Measured Test Result (tight/leak)
43	0.3	0	tight
44	0.3	3	leak
45	0.1	0	tight

Application of the Method

16. This release detection method 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, steel, or other and that typically measure 2 in. in diameter and 150 ft or less in length. The performance estimates are valid when:

- the method that was evaluated has not been substantially changed by subsequent modifications
- the vendor's instructions for using the method are followed
- a 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 hr
- the waiting time between the last dispensing of product through the pipeline system and the start of data collection for the test is 0 hr
- the total data collection time for the test is between 37 seconds and 5 minutes
- the volume of the product in the pipeline system is less than twice the volume of the product in the pipeline system used in the evaluation, unless a separate written justification for testing larger pipeline systems is presented by the vendor, concurred with by the evaluator, and included with this evaluation as an additional attachment.
- give any other limitations specified by the vendor or determined during the evaluation: _____

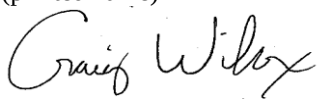
Attachments

Attachment 1 - Description of the Method Evaluated
Attachment 2 - Summary of the Performance of the Method 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

Certification of Results

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

Craig Wilcox
(printed name)



(signature)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Grain Valley, Missouri 64029
(city, state, zip)

November 12, 2023
(date)

(816) 443-2494
(phone number)

Attachment 1
Description

Pipeline Release Detection Method

The evaluator, with help from the vendor, fills out this form prior to the start of the evaluation. This form provides a description of the method and how it works. It should be filled out completely – check all appropriate boxes for each question. If *other* is checked, provide a description. For those answers dependent on site conditions, give answers that apply in typical conditions. This form is to be filled out by the evaluator with assistance from the vendor before the start of the evaluation. Describe the important features of the method as indicated below. A detailed description is not required, nor is it necessary to reveal proprietary features of the system.

Method Name and Version: _____

Date: _____

Applicability of the Method

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

   _X_ gasoline
   _ _ diesel
   _ _ aviation fuel
   _ _ fuel oil #4
   _ _ fuel oil #6
   _ _ solvent
   _ _ waste oil
   _ _ other (specify) _____

2. What types of pipelines can be tested? (Check all applicable responses.)
   X fiberglass
   X steel
   X other (specify) This system can be used on any pipeline type including rigid, flex and semi-rigid

3. Can this release detection method be used to test double-wall pipeline systems?
   X yes (primary pipe) ☐ no

4. What is the nominal diameter of a pipeline that can be tested with this method?
   _ _ 1 in. or less
   X between 1 and 3 in.
   X between 3 and 6 in.
   _ _ between 6 and 10 in.
   other _____

5. The method can be used on pipelines pressurized to _50_ psi

   The safe maximum operating pressure for this method is _200_ psi.

6. Does the method conduct a test while a mechanical line leak detector is in place in the pipeline?
   X Not applicable - The BFX1V is a mechanical line leak detector

General Features of the Method

7. What type of test is the method conducting? (Check all applicable responses.)
   __0.10 gal/hr Line Tightness Test
   __0.20 gal/hr Monthly Monitoring
   X_ 3 gal/hr Hourly

8. Is the method permanently installed on the pipeline?
   X yes ☐ no

   Does the method test the line automatically?
   X yes ☐ no

If a leak is declared, what does the method do? (Check all applicable responses.)
__ displays or prints a message
__ triggers an alarm
__ programmable alerts via Ethernet, serial, SMS, email-mail or internet
X Restricts the flow of fuel and does not allow for full pressure on the line past the leak detector

9. What quantity or quantities are measured by the method? (Please list.)

   This leak detector is a mechanical line leak detector. The leak detector detects if there is a 3 gal/hr or greater leak in the pipeline beyond the point where the leak detector installed.

10. Does the method 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 method 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?
    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 release detection test?
    X no waiting
    __period less than 15
    __min 15 min to 1 hr
    __1 to 5 hr
    __6 to 12 hr
    __12 to 24 hr greater
    __than 24 hr
    __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 release detection test?

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

15. What is the minimum amount of time necessary to set up equipment and complete a release 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.)
The test duration for this evaluation ranged from 37 seconds to 65 seconds for a tight test and 5 minutes for a test with a leak. The average time for a tight test was 50 seconds for the MLLD to open(pass) on a 589.34 gallon line as evaluated. For tests with a leak induced, the test duration was 5 minutes. The BFX1V MLLD remained in the restricted flow(leak detected) for the full duration of the 5 minute test (single test).
not applicable hr (multiple test)

16. Does the method compensate for those pressure or volume changes of the product in the pipeline that are due to temperature changes?
_ yes _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?
X no ☐ yes___

_____

_____

If yes, briefly specify:

21. Are elements of the test procedures determined by on-site testing 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
X other (Describe briefly.) _____

Data Acquisition

22. How are the test data acquired and recorded?

__ manually
__ by strip
__chart by
__computer
X This is a mechanical line leak detector, no data is acquired or recorded

23. Certain calculations are necessary to reduce and analyze the data. How are these calculations done?
__ manual calculations by the evaluator on site
__interactive computer program used by the
__automatically done with computer program
X This is a mechanical line leak detector, no data is acquired or recorded

Detection Criterion

24. What threshold is used to determine whether the pipeline is leaking?
Not applicable – this is an MLLD (in the units used by the measurement system)
Not applicable – this is an MLLD (in gal/hr)

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 3 questions below)

X no

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?
X never
__before each test
__weekly monthly
__semi-annually
__yearly or less frequently

Attachment 2
Summary Of Performance Estimates

Pipeline Release Detection Method
Hourly Test
First Test Of A Multiple-Test Sequence

Complete this page only if the method being evaluated requires, as part of its test procedures, more than one complete test to determine whether the pipeline is leaking. Method performance based on the first test alone must be reported on this form. Complete the first table. The last three tables present the performance of the method for different combinations of thresholds, probabilities of false alarm, and probabilities of detection. They are useful for comparing the performance of this method to that of other methods. However, completion of the last three tables is optional.

Performance Of The Pipeline Release Detection Method As Evaluated

Description	Leak Rate (gal/hr)	P(d)	P(fa)	Threshold (gal/hr)
Evaluated Method	3.0	100%	0%	N/A
EPA Standard	3.0	0.95	0.05	N/A

P(fa) As A Function Of Threshold

Threshold (gal/hr)	P(fa)
	0.10
	0.075
	0.05
	0.05

P(d) As A Function Of Threshold For A Leak Rate Of 3.0 gal/hr

Threshold (gal/hr)	P(d)
	0.95
	0.90
	0.80
	0.50

Smallest Leak Rate That Can Be Detected With The Specified P(d) and P(fa)

Leak Rate (gal/hr)	P(d)	P(fa)
	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)

Complete these tables to identify the configuration of the pipeline system.

Pipeline Release Detection Method At Test Facility Or Retail Station

Specialized Test Facility Or Operational UST Facility	
Inside diameter of pipeline (in.)	1.5" to 4"
Length of pipeline (tank to dispenser) (ft)	2533'
Volume of product in line during testing (gal)	589.34
Type of material (fiberglass, steel, other*)	Fiberglass, Flex and Semi-Rigid
Type of product in tank and pipeline (gasoline, diesel, other**)	Unleaded Gasoline
Was a mechanical line leak detector present? (yes or no)	No
Was trapped vapor present? (yes or no)	No
Compressibility (C) (psi)	17,052
C/Vo (psi/gal)	0.0077 psi/ml
Storage tank capacity (gal)	600

* Specify type of construction material.

Attachment 4
Hourly(3 gal/h) Tests
Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation
Veeder-Root BFX1V BFVD Manifold - Unleaded Fuel
Pipeline Leak Detection Systems
Options 1 and 5

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
1	9/14/2023	74.9	1178.68	60 min	1400	1300	74.9	74.9	74.9	74.9	74.9	0.0	neutral
2	9/14/2023	74.9	1178.68	60 min	1400	1300	74.9	74.9	74.9	74.9	74.9	0.0	neutral
3	9/18/2023	74.9	1178.68	60 min	1109	1009	74.9	74.0	74.0	74.0	74.0	0.9	neutral
4	9/18/2023	74.9	1178.68	60 min	1109	1009	74.9	74.0	74.0	74.0	74.0	0.9	neutral
5	9/18/2023	58.3	1178.68	60 min	1328	1228	58.3	74.2	74.2	74.1	74.1	-15.8	< -10 deg
6	9/18/2023	58.3	1178.68	60 min	1328	1228	58.3	74.2	74.2	74.1	74.1	-15.8	< -10 deg
7	9/18/2023	63.5	1178.68	60 min	1452	1352	63.5	72.8	73.6	74.2	73.9	-10.4	< -10 deg
8	9/18/2023	63.5	1178.68	60 min	1452	1352	63.5	72.8	73.6	74.2	73.9	-10.4	< -10 deg
9	9/18/2023	61.3	1178.68	60 min	1605	1505	61.3	72.3	73.5	74.1	73.8	-12.5	< -10 deg
10	9/18/2023	61.3	1178.68	60 min	1605	1505	61.3	72.3	73.5	74.1	73.8	-12.5	< -10 deg
11	9/18/2023	63.6	1178.68	60 min	1725	1625	63.6	72.0	73.3	74.1	73.7	-10.1	< -10 deg
12	9/18/2023	63.6	1178.68	60 min	1725	1625	63.6	72.0	73.3	74.1	73.7	-10.1	< -10 deg
13	9/18/2023	63.4	1178.68	60 min	1930	1830	63.4	71.9	73.2	74.0	73.6	-10.2	< -10 deg
14	9/18/2023	63.4	1178.68	60 min	1930	1830	63.4	71.9	73.2	74.0	73.6	-10.2	< -10 deg
15	9/18/2023	63.0	1178.68	60 min	2113	2030	63.0	71.7	73.1	73.9	73.5	-10.5	< -10 deg
16	9/18/2023	63.0	1178.68	60 min	2113	2030	63.0	71.7	73.1	73.9	73.5	-10.5	< -10 deg
17	9/19/2023	58.5	1178.68	60 min	1553	1453	58.5	72.5	72.9	73.4	73.2	-14.7	< -10 deg
18	9/19/2023	58.5	1178.68	60 min	1553	1453	58.5	72.5	72.9	73.4	73.2	-14.7	< -10 deg
19	9/19/2023	70.1	1178.68	60 min	1720	1620	70.1	71.7	72.8	73.4	73.1	-3.0	neutral
20	9/19/2023	70.1	1178.68	60 min	1720	1620	70.1	71.7	72.8	73.4	73.1	-3.0	neutral
21	9/20/2023	88.5	1178.68	60 min	1900	1800	88.5	73.2	73.3	73.5	73.4	15.1	>+10

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category	
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)	
22	9/20/2023	88.5	1178.68	60 min	1900	1800	88.5	73.2	73.3	73.5	73.4	15.1	>+10	
23	9/21/2023	84.3	1178.68	60 min	2021	1921	84.3	74.6	73.8	73.5	73.7	10.6	>+10	
24	9/21/2023	84.3	1178.68	60 min	2021	1921	84.3	74.6	73.8	73.5	73.7	10.6	>+10	
25	9/21/2023	84.3	1178.68	60 min	1549	1449	84.3	74.2	74.0	74.0	74.0	10.3	>+10	
26	9/21/2023	84.3	1178.68	60 min	1549	1449	84.3	74.2	74.0	74.0	74.0	10.3	>+10	
27	9/21/2023	84.5	1178.68	60 min	1745	1645	84.5	75.4	74.5	74.1	74.3	10.2	>+10	
28	9/21/2023	84.5	1178.68	60 min	1745	1645	84.5	75.4	74.5	74.1	74.3	10.2	>+10	
29	9/21/2023	84.8	1178.68	60 min	1909	1809	84.8	76.3	74.7	74.2	74.5	10.3	>+10	
30	9/21/2023	84.8	1178.68	60 min	1909	1809	84.8	76.3	74.7	74.2	74.5	10.3	>+10	
31	9/22/2023	74.8	1178.68	60 min	1350	1250	74.8	74.5	74.4	74.3	74.3	0.5	neutral	
32	9/22/2023	74.8	1178.68	60 min	1350	1250	74.8	74.5	74.4	74.3	74.3	0.5	neutral	
33	9/22/2023	85.8	1178.68	60 min	1512	1412	85.8	74.5	74.4	74.3	74.3	11.5	>+10	
34	9/22/2023	85.8	1178.68	60 min	1512	1412	85.8	74.5	74.4	74.3	74.3	11.5	>+10	
35	9/22/2023	84.8	1178.68	60 min	1626	1526	84.8	75.7	74.5	74.3	74.5	10.3	>+10	
36	9/22/2023	84.8	1178.68	60 min	1626	1526	84.8	75.7	74.5	74.3	74.5	10.3	>+10	
37	9/22/2023	75.1	1178.68	60 min	1750	1650	75.1	75.9	75.0	74.5	74.8	0.3	neutral	
38	9/22/2023	75.1	1178.68	60 min	1750	1650	75.1	75.9	75.0	74.5	74.8	0.3	neutral	
39	9/24/2023	74.0	1178.68	60 min	1850	1750	74.0	73.9	73.9	73.9	73.9	0.1	neutral	
40	9/24/2023	74.0	1178.68	60 min	1850	1750	74.0	73.9	73.9	73.9	73.9	0.1	neutral	
41	9/25/2023	73.7	1178.68	60 min	1402	1302	73.7	73.5	73.5	73.5	73.5	0.2	neutral	
42	9/25/2023	73.7	1178.68	60 min	1402	1302	73.7	73.5	73.5	73.5	73.5	0.2	neutral	
43	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral	vapor
44	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral	vapor
45	9/26/2023	73.6	1178.68	60 min	1528	1428	73.6	73.6	73.5	73.5	73.5	0.1	neutral	vapor

Attachment 5

Hourly (3gal/h)

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

Veeder-Root BFX1V BFVD Manifold - Unleaded Fuel

Pipeline Release Detection Method *At a Test Facility*

Test No. (Based on Temperature Condition	Date Test Began	Induced Leak Rate	Time Circulation Ended	Time Between End of of Circulation and Start of Data Collection for Test	Time Data Collection Began	Time Data Collection Ended	Measured Test Result	Was Threshold Exceeded?	Test Duration for leak result tests	Test Duration for tight result tests	
	(D-M-Y)	(gal/hr)	(military)	(min)	(military)	(military)	(leak or tight)	(yes or no)	(seconds)	(seconds)	
1	9/14/2023	0	1400	6	1406	1407	tight	no		63	
2	9/14/2023	3	1400	7	1407	1412	leak	yes	300		
3	9/18/2023	0	1109	6	1115	1116	tight	no		61	
4	9/18/2023	3	1109	7	1116	1121	leak	yes	300		
5	9/18/2023	0	1328	6	1335	1336	tight	no		47	
6	9/18/2023	3	1328	7	1336	1341	leak	yes	300		
7	9/18/2023	0	1452	6	1458	1459	tight	no		60	
8	9/18/2023	3	1452	7	1459	1504	leak	yes	300		
9	9/18/2023	0	1605	6	1611	1612	tight	no		52	
10	9/18/2023	3	1605	7	1612	1617	leak	yes	300		
11	9/18/2023	0	1725	6	1731	1732	tight	no		48	
12	9/18/2023	3	1725	7	1732	1737	leak	yes	300		
13	9/18/2023	0	1930	6	1936	1937	tight	no		46	
14	9/18/2023	3	1930	7	1937	1942	leak	yes	300		
15	9/18/2023	0	2113	6	2119	2120	tight	no		47	
16	9/18/2023	3	2113	7	2120	2125	leak	yes	300		
17	9/19/2023	0	1553	6	1559	1600	tight	no		44	
18	9/19/2023	3	1553	7	1600	1605	leak	yes	300		
19	9/19/2023	0	1720	6	1726	1727	tight	no		38	
20	9/19/2023	3	1720	7	1727	1732	leak	yes	300		
21	9/20/2023	0	1900	6	1906	1907	tight	no		49	
22	9/20/2023	3	1900	7	1907	1912	leak	yes	300		
23	9/21/2023	0	2021	6	2027	2028	tight	no		53	
24	9/21/2023	3	2021	7	2028	2033	leak	yes	300		
25	9/21/2023	0	1549	6	1555	1556	tight	no		44	
26	9/21/2023	3	1549	7	1556	1601	leak	yes	300		
27	9/21/2023	0	1745	6	1751	1752	tight	no		48	
28	9/21/2023	3	1745	7	1752	1757	leak	yes	300		
29	9/21/2023	0	1909	6	1915	1916	tight	no		47	
30	9/21/2023	3	1909	7	1916	1921	leak	yes	300		
31	9/22/2023	0	1350	6	1356	1357	tight	no		42	
32	9/22/2023	3	1350	7	1357	1402	leak	yes	300		
33	9/22/2023	0	1512	6	1518	1519	tight	no		50	
34	9/22/2023	3	1512	7	1519	1524	leak	yes	300		
35	9/22/2023	0	1626	6	1632	1633	tight	no		56	
36	9/22/2023	3	1626	7	1633	1638	leak	yes	300		
37	9/22/2023	0	1750	6	1756	1757	tight	no		51	
38	9/22/2023	3	1750	7	1757	1602	leak	yes	300		
39	9/24/2023	0	1850	6	1856	1857	tight	no		65	
40	9/24/2023	3	1850	7	1857	1902	leak	yes	300		
41	9/25/2023	0	1402	6	1408	1409	tight	no		41	
42	9/25/2023	3	1402	7	1409	1414	leak	yes	300		
43	9/26/2023	0	1405	6	1411	1412	tight	no		57	vapor
44	9/26/2023	3	1405	7	1412	1417	leak	yes	300		vapor
45	9/26/2023	0	1528	1	1529	1530	tight	no		37	vapor

Attachment 6

Hourly (3.0 gal/hr)

Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Veeder-Root BFX1V BFVD Manifold - Unleaded Fuel

Pipeline Leak Detection System

Options 1 and 5

Summary of Temperature Conditions

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
43	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral
44	9/26/2023	73.8	1178.68	60 min	1405	1305	73.8	73.6	73.5	73.5	73.5	0.3	neutral
45	9/26/2023	73.6	1178.68	60 min	1528	1428	73.6	73.6	73.5	73.5	73.5	0.1	neutral

Summary of Leak Rates

Test No.	Date Test Began	Pipeline Pressure	Induced Leak Rate	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-min)	(local military)	(local military)	(Tight or Leak)	(Yes or No)
43	9/26/2023	30	0	6	1411	1412	Tight	No
44	9/26/2023	30	3	7	1412	1417	Leak	Yes
45	9/26/2023	30	0	1	1529	1530	Tight	No

Evaluation of the Veeder-Root BFX1DV Mechanical Pipeline Leak Detector, STP Mounted, for Hourly Testing on Rigid, Flexible and Hybrid Pipelines

Final Report Version 1

PREPARED FOR

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November 10, 2023

Preface

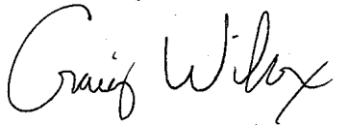
This report was prepared for Veeder-Root by Ken Wilcox Associates, Inc. This report presents the results of an independent performance evaluation of the Veeder-Root BFX1DV Mechanical Pipeline Leak Detector(MLLD), when mounted in a Submersible Turbine Pump(STP), for use on rigid, flexible, and combined pipelines.

This report covers the performance of the BFX1DV MLLD, when mounted in an STP, for Hourly (3gph) testing for pressurized piping. The purpose of the current testing is to show that the system performs adequately when tested on rigid, flexible as well as hybrid piping. Testing for this evaluation was performed in accordance with the US EPA protocol “Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection”, May 2019. The results indicate that the BFX1DV MLLD when mounted in an STP will successfully detect a leak of 3gph on flexible, rigid and hybrid pipeline systems.

The work was conducted at the Fuels Management Research Center, which is operated by Ken Wilcox Associates, Inc. This report was prepared by Craig D Wilcox for, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to the Veeder-Root Engineering Department at 860-651-2700.

November 10, 2023 KEN WILCOX ASSOCIATES, INC.

Approved:



Craig D Wilcox
President

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Executive Summary

This report presents the results of an independent evaluation of the BFX1DV MLLD when mounted in an STP for hourly testing on flexible, rigid and combination pipelines. The test procedures used were those described in the US EPA protocol “Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection”, May 2019.

The performance capabilities of the BFX1DV MLLD, when mounted in an STP, were determined for Hourly Testing. The BFX1DV MLLD, when mounted in an STP, met the US EPA performance standards for hourly pipeline leak detection systems which require a probability of detecting a leak of stated size be 95% or greater with a probability of false alarm (declaring a tight line to be leaking) of no more than 5%.

The BFX1DV MLLD, when mounted in an STP, was tested on a pipeline consisting of rigid, semi-rigid and flexible pipe. The total line volume for hourly testing was 589.34 gallons of diesel fuel with a bulk modulus of 17,052 psi. The pipeline configuration used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the three line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex.

The formal results of the evaluation are reported on the Official EPA forms in Attachment A, B and C of this report.

1.0 Introduction

The federal Environmental Protection Agency (EPA) has provided a series of documents[1] that describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.[2] At the minimum, a leak detector that is capable of detecting leaks of 3.0 gallons per hour (gal/hr) at 10 psi or larger on an hourly basis must be installed on all pressurized pipelines. The probability of detecting a leak of stated size must be 95% or greater with a probability of a false alarm (declaring a tight line to be leaking) of no more than 5%.

This report presents the results of an independent evaluation of the performance of the BFX1DV MLLD, when mounted in an STP, for testing on rigid, semi-rigid, flexible and combined pipelines. The evaluation was conducted by Ken Wilcox Associates, Inc. at the Fuels Management Research Center in Grain Valley, Missouri. Testing for this evaluation was performed in accordance with the US EPA protocol "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

A total of 45 tests were conducted to verify that the leak detector could detect 3 gal/hr leaks on Flexible, Rigid and Hybrid pipelines containing diesel fuel. The results of this testing indicate that the BFX1DV MLLD, when mounted in an STP, for testing on rigid, flexible, and combined pipelines will successfully perform Hourly Testing on Flexible, Rigid and Hybrid pipeline systems.

[1] "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

[2] 40CFR Part 280, Subpart D.

2.0 Overview of Evaluation Procedures

A total of 45 tests were conducted for this evaluation on the BFX1DV MLLD, when mounted in an STP. The test conditions for these tests are provided in Table 3. Out of the 45 Hourly tests that were performed, 23 were run with no leak and 22 were run with a leak. Testing was conducted with temperature differentials between the ground and the fuel (that was circulated through the pipeline) at temperature three different temperature differentials including +10, 0 and -10 degrees Fahrenheit.

Testing was carried out using the manufacturer's normal test routine. The BFX1DV MLLD, when mounted in an STP, was in the line in its usual configuration. The temperature of the product in the pipeline tank was varied relative to the surrounding soil temperature. Product was then circulated through the line for twice the line volume and leaks were induced at rates equivalent to 3 gal/h at 10 psi for the Hourly testing as specified in the US EPA protocol. Tests were also run with a zero leak rate; that is, with the line in the tight condition. The induced leak rates were established during the circulation period by introducing a controlled flow through a variable cross-sectional area flow meter.

Testing for this evaluation was performed in accordance with the US EPA protocol. The EPA test protocol requires that 21 leak tests, 21 tight tests and 3 tests with vapor present in the line to be conducted, for each of the hourly testing, with various temperature differentials between product in the line and the ground.

Briefly summarized, the test procedures were as follows:

1) Product was conditioned in the pipeline tank to the required temperature. The soil temperature was monitored throughout the entire test at distances of 2, 4, and 12 inches from the pipeline to determine proper temperature differentials.
2) Product was circulated through the pipeline at a rate of approximately 19.7 gal/min for twice the volume of the pipeline (60 minutes).
3) Flow in the line was stopped by closing the outlet valve while the submersible pump was still on. The pump was then turned off and the outlet valve opened to lower the pressure down to zero pressure(less than 1 psi).
4) For a test with a leak to be induced, a pre-calibrated leak was turned on with a leak equivalent to 3 gal/h at 10 psi.
5) The submersible turbine pump dispenser switch was then turned on and the leak detector conducted the test.
6) Steps 1 through 5 were repeated for every set of tests with both tight tests and induced leak tests.

3.0 Description of the Test Equipment

The Veeder-Root BFX1DV is a mechanical line leak detector. For this evaluation, the Veeder-Root BFX1DV MLLD was mounted in an STP. The BFX1DV mechanical line leak detector is designed to be permanently installed in the fuel line, and performs a 3 gal/h hourly test automatically. If a leak is detected by the BFX1DV, fuel flow is restricted to the dispensers. The BFX1DV sample used in this evaluation had a part # of 410983-001 and a serial # of 107235016. The pictures of the unit evaluated are shown in Image 1 thru 4.

Image 1

Image 2

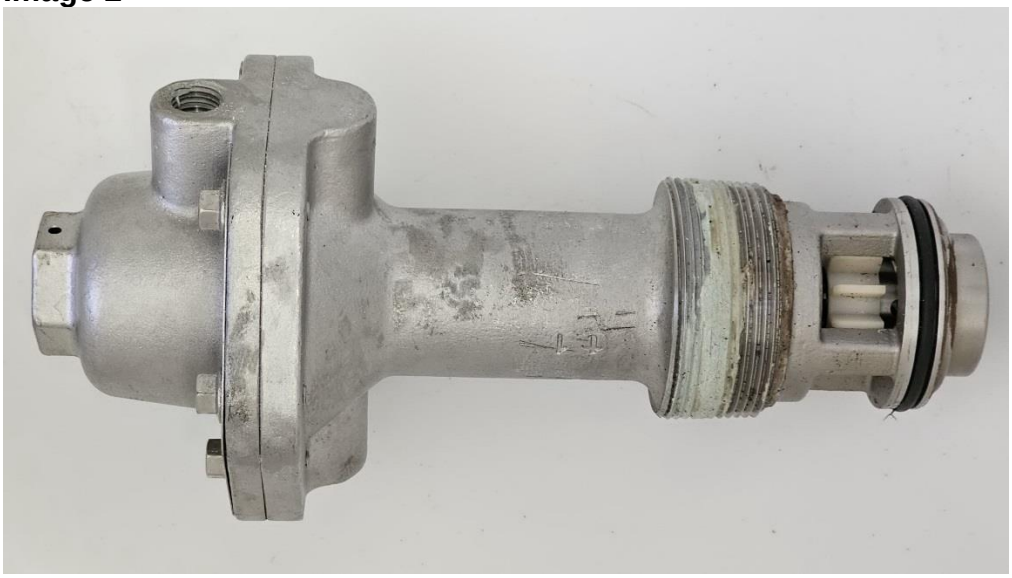


Image 3

Image 4

4.0 Description of the Testing Location

The BFX1DV MLLD, when mounted in an STP, was evaluated at the Fuels Management Research Center located in Grain Valley, Missouri, which is operated by Ken Wilcox Associates, Inc. Line tests described in this report were conducted on the combination of pipeline detailed in Table 1. Table 1 shows the pipeline configuration and product used, along with the volumes of the line combination. The bulk modulus, which is a measure of the "stretch" which occurs when the line is pressurized, is shown in Attachment 3. Details of the piping configuration used in the evaluation are included in table 1.

The conditioned product is contained in a 600 gallon steel tank, which is equipped with a standard Red Jacket submersible pump. Product is heated or cooled in the tank by circulating glycol and product through an external heat exchanger. Soil temperatures were monitored using RTDs, which were located at 2 inches, 4 inches and 12 inches from the line as specified by the EPA protocol. A single temperature probe was located 4 inches from the bottom of the product conditioning tank. The weighted soil temperature and the product tank temperature at the beginning of the test were used to compute the temperature differential.

Table 1. Pipeline Configurations Used for Hourly Testing

Segment	Construction	Length (ft)	Diameter (in)	Volume (gal)
1	FRP - single wall	34	3.125	13.55
2	FRP Double wall	200	4	130.38
3	FRP - single wall	40	3.125	16.45
4	Flex -double wall	34	1.5	3.12
5	Flex double wall	130	3.125	51.8
6	FRP - single wall	104	3.125	41.44
7	FRP - single wall	27	3.125	11.1
8	NUPI - TSMAXPD	1964	2	321.5
Total				589.34

Rigid Volume Used (segment 1,2,3,6,7) – 212.92 gallons
Semi-Rigid Volume Used (segment 8) – 321.5 gallons
Flex Volume Used (segment 4,5) – 54.92 gallons
Maximum Volume (2X evaluated) Allowable for Pipeline Testing = 1178.68 gallons
Bulk Modulus of combination line = 17,052 psi

5.0 Test Results and Discussion

The test results of the BFX1DV MLLD, when mounted in an STP, were compared to the leak conditions induced in the line. Forty-five hourly tests were conducted using the procedures described in Section 2.0 of this report. For the hourly testing 22 of these tests were run with a 3 gal/h leak induced in the line and 23 were run with the line in the tight condition and 3 of these tests were performed with vapor in the line. During all of the hourly testing, the BFX1DV allowed the pipeline to open to full pressure (tight result) with the line in the tight condition and restricted flow (detected leak) during all tests with a 3 gal/hr leak induced. This detected leak or passing test by the BFX1DV MLLD was compared to the induced leak or no leak and the results are reported in Appendix B.

Testing was conducted using procedures specified in the US EPA protocol. For the hourly testing, the results of the evaluation have been calculated using Section 5.2 of the US EPA procedures for systems that do not report a leak rate. The results of the data analysis have been summarized in Table 3. The pipeline configuration is described more completely using the EPA Pipeline Protocol Attachment 3 reported as Table 3. The test data for this evaluation are contained in Attachment 4 and 5 and 6, which correspond to Attachments 4, 5 and 6 of the US EPA Protocol.

Calculation of P_{FA} and P_D

Since the BFX1DV MLLD hourly tests are a pass/fail system, the calculation of the Probability of Detection (P_D) and the Probability of False Alarm (P_{FA}) was based on the number of correct test results compared to the number of tests of that type. For these standards, the statistics for estimating P_{FA} and P_D were based on the calculations found in Section 5.21 and 5.22 of the pipeline protocol.

Performance for Hourly (3.0 gal/hr) Testing

A total of 45 tests (23 tight and 22 with induced leaks) were conducted for the system. A total of 3 tests (2 tight and 1 with an induced leak) with trapped vapor were conducted for the system. There were no missed detections or false alarms observed for these 45 tests. Forty-five tests were conducted on the system including the three tests with trapped vapor. The P_D and P_{FA} were calculated by dividing the number of correct results by the total number of such tests that were conducted. Since there were no false alarms or missed detections using the hourly test, the estimated P_{FA} was 0% and the estimated P_D was 100%. Since one cannot assume that a qualitative method would never make a mistake only based on about 45 tests, a 95% confidence limit was calculated for each parameter. Based on these calculations, one can be 95% confident that the P_{FA} is between 0% and 12.73%, while the 95% confidence limit for P_D is from 87.79% to 100%. The tests that were performed without a leak induced, ranged from 21 seconds to 93 seconds with an average test time of 46 seconds. The test was determined as tight at the moment when the leak detector opened and allowed full pressure to the pipeline. For each of the tests with a 3 gal/h leak induced, the BFX1DV

leak detector restricted the flow to the pipeline and held the pressure at a lower PSI for the full 5 minute duration. After 5 minutes of restricted flow, the test was declared and recorded as a leak result. It is important to note that the 5 minute test time was a KWA selected maximum time to allow for the leak detector to open (passing result) or remain in restricted flow (leak result) for all tests.

Maximum Line Size for Hourly Testing

The EPA allows for line leak detectors to be used on lines up to twice the volume that they were evaluated on. In this evaluation the lines were a total of 2533 feet in length. The volume of the pipeline configuration was 589.34 gallons. The pipeline used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the 3 line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex. Thus, if the EPA allowance is applied to these tests of twice the volume evaluated, the BFX1DV MLLD, when mounted in an STP, for hourly testing can be used on lines up to a total volume of 1178.68 gallons.

Waiting Times

Waiting times after the delivery of product, after product is circulated through the line or after pumping has stopped are not necessary before valid tests can be conducted. For the Hourly testing, 2 tests were run after each circulation. As a result, the waiting times for the hourly testing ranged from 0 minutes to 1 minute, with an average of 30 seconds.

Table 3. Performance Parameters for the Veeder-Root BFX1DV Mechanical line Leak Detector, Pump Mounted, for Flexible, Rigid, and Hybrid Pipelines Using the EPA Protocol

Parameter	Value
Probability of Detection (P_D) of a 3.0 gal/hr leak (Hourly)	100% (87.79% to 100%)
Probability of False Alarm (Hourly P_{FA})	0% (0% to 12.73%)
Maximum Line Size	Combination of all piping, flexible or rigid or in combination limited to a total capacity of 1178.68 gal. for hourly testing
Waiting Time after Delivery of Product before Conducting a Test	None Required
Waiting Time after Product Circulation Through Line before Conducting a Test	None Required
Hourly Test Times with a 3.0 gal/hr Leak	Range: 5 minutes
Hourly Test Times without Leak	Range: 21 to 93 seconds

6.0 Conclusions

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

- The observed P_D for a 3.0 gal/h leak was 100% and the P_{FA} on a tight line was 0.0%.
- Using the EPA protocol, the BFX1DV MLLD, when mounted in an STP, can be used on any pipeline for hourly testing up to 1178.68 gallons in volume including rigid, flexible or a combination of pipeline types.
- A waiting time after product is circulated through the line or after pumping has stopped is not necessary before conducting a valid test.
- A waiting time after delivery of product is not necessary before a valid test can be conducted.

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

Options 1, 2, and 5

Pipeline Leak Detection System for Annual, Monthly and Hourly Testing

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.) [1]	Range from 1.5 in to 4 in*
Length of pipeline (tank to dispenser) (ft) [2]	Rigid – 405ft Semi-Rigid – 1964ft Flex - 164ft **Total Length - 2533 ft**
Volume of product in line during testing (gal) [3]	Rigid – 212.92 gal Semi-Rigid – 321.5 gal Flex – 54.92 gal **Total Volume - 589.34 gal**
Type of material (fiberglass, steel, other[4])	Rigid (FRP), Semi-Rigid and Flex
Type of product in tank and pipeline (gasoline, diesel, other[5])	#2 Diesel fuel
Was a mechanical line leak detector present? (yes or no)	yes
Was trapped vapor present? (yes or no)	Yes(vapor tests only)
Bulk Modulus (B) (psi)	17,052 psi
B/V (psi/ml)	0.0077 psi/ml
Storage tank capacity (gal)	600 gal

[1]Specify for each section of pipe, if different.
[2]Specify length of each section of pipe, if different size or material.
[3]Specify volume for each section of pipe, if different size or type.
[4]Specify type of construction material for each pipe section.
[5]Specify type of product for each tank.

APENDIX A

Hourly (3 gal/h) Results and Attachments

Results Of U.S. EPA Standard Evaluation
Pipeline Release Detection Method

Hourly Test

This form summarizes the results of an evaluation to determine whether the pipeline release detection method named below and described in Attachment 1 complies with the federal UST regulation for conducting an hourly test. The evaluation was conducted according to the U.S. EPA's evaluation procedures, specified in *Standard Test Procedures for Evaluating Release Detection Methods: Pipeline Release Detection*. The full evaluation report includes six attachments.

UST system owners and operators who use this pipeline release detection method should keep this form on file to show compliance with the federal UST regulation. UST system owners and operators should check with state and local regulatory authorities to make sure this form satisfies the requirements of their agencies.

Method Evaluated

Method Name: BFX1DV Mechanical Line Leak Detector

Version of Method: BFX1DV Mechanical Line Leak Detector, mounted in an STP

Version of System: BFX1DV

Manufacturer Name: Veeder-Root

125 Powder Forest Drive
(street address)

Simsbury, CT 06070 (860) 651-2700
(city, state, zip code) (Phone number)

Evaluation Results

1. The performance of this method
   X meets or exceeds
   __ does not meet the federal standards established by the EPA regulation for hourly tests.

   The EPA regulation for an hourly test requires that the method be capable of detecting a leak as small as 3.0 gal/hr 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 3.0 gal/hr defined at a pipeline pressure of 10 psi in this evaluation is 100 %.

Criterion for Declaring a Leak

3. This method
   __uses a preset threshold
   __ measures and reports the output quantity and compares it to a predetermined threshold to determine whether the pipeline is leaking.
   _X_ Other The BFX1DV is a mechanical line leak detector. If a 3gal/hr leak is present, the BFX1DV will restrict the flow of fuel. If there is no leak present, the leak detector will open up and will allow for the maximum flow of fuel that is produced by the submersible turbine pump.

4. This method
   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 method declares a leak if the output of the measurement method exceeds a threshold of 3.0 gallon per hour (specify flow rate in gal/hr) in 1 out of 1 tests (specify, for example, 1 out of 2, 2 out of 3). Please give additional details, if necessary, in the space provided.

Evaluation Approach

6. A total of 23 tests were conducted on non-leaking tank(s) between 08/16/2023__(date) and 08/25/2023 (date). A description of the pipeline configuration used in the evaluation is given in Attachment 3.

7. The pipeline used in the evaluation was between 1.5 and 4 in. in diameter, 2533ft long and constructed of rigid(FRP), semi-rigid and flex (fiberglass, steel, or other).

8. A mechanical line leak detector
   __ was
   X was not present in the pipeline system.

9. The evaluation was conducted on 1 (how many) pipeline systems ranging in diameter from 1.5 in. to 4 in., ranging in length from 2533 ft to 2533 ft, and constructed of rigid(FRP), semi-rigid and flex (specify materials).

10. Please specify how much time elapsed between the delivery of product and the start of the data collection:
    X 0 to 6 hr
    __6 to 12 hr
    __12 to 24
    __hr >24 hr

Data Used to Make Performance Estimates

11. The induced leak rate and the test results used to estimate the performance of this method 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

12. _X_ According to the vendor, this method can be used even if trapped vapor is present in the pipeline during a test.
___ According to the vendor, this method *should not be used* if trapped vapor is present in the pipeline.

13. The sensitivity of this method to trapped vapor is indicated by the test results summarized in Table 1. These tests were conducted at 30 psi with 500 mL of vapor trapped in the line at a pressure of 0 psi. The data and test conditions are reported in Attachment 6.

Table 1. Summary of the Results of Trapped Vapor Tests

Test No.	Delta T (deg F)	Induced Leak Rate (gal/h)	Measured Test Result (tight/leak)
15	1.1	0	tight
16	1.1	3	leak
33	-4.1	0	tight

Application of the Method

16. This release detection method 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, steel, or other and that typically measure 2 in. in diameter and 150 ft or less in length. The performance estimates are valid when:

- the method that was evaluated has not been substantially changed by subsequent modifications
- the vendor's instructions for using the method are followed
- a 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 hr
- the waiting time between the last dispensing of product through the pipeline system and the start of data collection for the test is 0 hr
- the total data collection time for the test is between 21 seconds and 5 minutes
- the volume of the product in the pipeline system is less than twice the volume of the product in the pipeline system used in the evaluation, unless a separate written justification for testing larger pipeline systems is presented by the vendor, concurred with by the evaluator, and included with this evaluation as an additional attachment.
- give any other limitations specified by the vendor or determined during the evaluation: _____

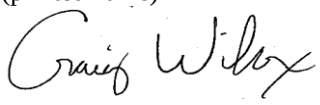
Attachments

Attachment 1 - Description of the Method Evaluated
Attachment 2 - Summary of the Performance of the Method 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

Certification of Results

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

Craig Wilcox
(printed name)



(signature)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Grain Valley, Missouri 64029
(city, state, zip)

November 10, 2023
(date)

(816) 443-2494
(phone number)

Attachment 1
Description

Pipeline Release Detection Method

The evaluator, with help from the vendor, fills out this form prior to the start of the evaluation. This form provides a description of the method and how it works. It should be filled out completely – check all appropriate boxes for each question. If *other* is checked, provide a description. For those answers dependent on site conditions, give answers that apply in typical conditions. This form is to be filled out by the evaluator with assistance from the vendor before the start of the evaluation. Describe the important features of the method as indicated below. A detailed description is not required, nor is it necessary to reveal proprietary features of the system.

Method Name and Version: _____

Date: _____

Applicability of the Method

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

   _gasoline
   X diesel
   _aviation fuel
   _fuel oil #4
   _fuel oil #6
   _solvent
   _waste oil
   _ other (specify) _____

2. What types of pipelines can be tested? (Check all applicable responses.)
   X fiberglass
   X steel
   X other (specify) This system can be used on any pipeline type including rigid, flex and semi-rigid

3. Can this release detection method be used to test double-wall pipeline systems?
   X yes (primary pipe) ☐ no

4. What is the nominal diameter of a pipeline that can be tested with this method?
   __1 in. or less
   X between 1 and 3 in.
   X between 3 and 6 in.
   __between 6 and 10 in.
   other _____

5. The method can be used on pipelines pressurized to _50_ psi

   The safe maximum operating pressure for this method is _200__ psi.

6. Does the method conduct a test while a mechanical line leak detector is in place in the pipeline?
   X Not applicable - The BFX1DV is a mechanical line leak detector

General Features of the Method

7. What type of test is the method conducting? (Check all applicable responses.)
   __0.10 gal/hr Line Tightness Test
   __0.20 gal/hr Monthly Monitoring
   X_ 3 gal/hr Hourly

8. Is the method permanently installed on the pipeline?
   X yes ☐ no

   Does the method test the line automatically?
   X yes ☐ no

If a leak is declared, what does the method do? (Check all applicable responses.)
__ displays or prints a message
__ triggers an alarm
__ programmable alerts via Ethernet, serial, SMS, email-mail or internet
X Restricts the flow of fuel and does not allow for full pressure on the line past the leak detector

9. What quantity or quantities are measured by the method? (Please list.)

   This leak detector is a mechanical line leak detector. The leak detector detects if there is a 3 gal/hr or greater leak in the pipeline beyond the point where the leak detector installed.

10. Does the method 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 method 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?
    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 release detection test?
    X no waiting
    __period less than 15
    __min 15 min to 1 hr
    __1 to 5 hr
    __6 to 12 hr
    __12 to 24 hr greater
    __than 24 hr
    __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 release detection test?

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

15. What is the minimum amount of time necessary to set up equipment and complete a release 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.)

The test duration for this evaluation ranged from 21 seconds to 93 seconds for a tight test and 5 minutes for a test with a leak. The average time for a tight test was 46 seconds for the MLLD to open(pass) on a 589.34 gallon line as evaluated. For tests with a leak induced, the test duration was 5 minutes. The BFX1DV MLLD remained in the restricted flow(leak detected) for the full duration of the 5 minute test (single test).

not applicable hr (multiple test)

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

_ yes 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?

X no ☐ yes___

_____

_____

If yes, briefly specify:

21. Are elements of the test procedures determined by on-site testing 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
X other (Describe briefly.) _____

Data Acquisition

22. How are the test data acquired and recorded?

__ manually
__ by strip
__chart by
__computer
X This is a mechanical line leak detector, no data is acquired or recorded

23. Certain calculations are necessary to reduce and analyze the data. How are these calculations done?
__ manual calculations by the evaluator on site
__interactive computer program used by the
__automatically done with computer program
X This is a mechanical line leak detector, no data is acquired or recorded

Detection Criterion

24. What threshold is used to determine whether the pipeline is leaking?
Not applicable – this is an MLLD (in the units used by the measurement system)
Not applicable – this is an MLLD (in gal/hr)

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 3 questions below)

X no

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?
X never
__before each test
__weekly monthly
__semi-annually
__yearly or less frequently

Attachment 2
Summary Of Performance Estimates

Pipeline Release Detection Method
Hourly Test
First Test Of A Multiple-Test Sequence

Complete this page only if the method being evaluated requires, as part of its test procedures, more than one complete test to determine whether the pipeline is leaking. Method performance based on the first test alone must be reported on this form. Complete the first table. The last three tables present the performance of the method for different combinations of thresholds, probabilities of false alarm, and probabilities of detection. They are useful for comparing the performance of this method to that of other methods. However, completion of the last three tables is optional.

Performance Of The Pipeline Release Detection Method As Evaluated

Description	Leak Rate (gal/hr)	P(d)	P(fa)	Threshold (gal/hr)
Evaluated Method	3.0	100%	0%	N/A
EPA Standard	3.0	0.95	0.05	N/A

P(fa) As A Function Of Threshold

Threshold (gal/hr)	P(fa)
	0.10
	0.075
	0.05
	0.05

P(d) As A Function Of Threshold For A Leak Rate Of 3.0 gal/hr

Threshold (gal/hr)	P(d)
	0.95
	0.90
	0.80
	0.50

Smallest Leak Rate That Can Be Detected With The Specified P(d) and P(fa)

Leak Rate (gal/hr)	P(d)	P(fa)
	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)

Complete these tables to identify the configuration of the pipeline system.

Pipeline Release Detection Method At Test Facility Or Retail Station

Specialized Test Facility Or Operational UST Facility	
Inside diameter of pipeline (in.)	1.5" to 4"
Length of pipeline (tank to dispenser) (ft)	2533'
Volume of product in line during testing (gal)	589.34
Type of material (fiberglass, steel, other*)	Fiberglass, Flex and Semi-Rigid
Type of product in tank and pipeline (gasoline, diesel, other**)	Diesel #2
Was a mechanical line leak detector present? (yes or no)	No
Was trapped vapor present? (yes or no)	No
Compressibility (C) (psi)	17,052
C/Vo (psi/gal)	0.0077 psi/ml
Storage tank capacity (gal)	600

* Specify type of construction material.

Attachment 4
Hourly(3 gal/h) Tests
Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation
Veeder-Root BFX-1DV Pump Mounted - Diesel Fuel
Pipeline Leak Detection Systems
Options 1 and 5

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category	
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)	
1	8/16/2023	75.3	1178.68	60 min	1306	1206	75.3	75.1	75.1	75.1	75.1	0.2	neutral	
2	8/16/2023	75.3	1178.68	60 min	1306	1206	75.3	75.1	75.1	75.1	75.1	0.2	neutral	
3	8/16/2023	75.6	1178.68	60 min	1519	1419	75.6	75.1	75.1	75.1	75.1	0.5	neutral	
4	8/16/2023	75.6	1178.68	60 min	1519	1419	75.6	75.1	75.1	75.1	75.1	0.5	neutral	
5	8/18/2023	77.1	1178.68	60 min	1105	1005	77.1	77.1	77.1	77.1	77.1	0.0	neutral	
6	8/18/2023	77.1	1178.68	60 min	1105	1005	77.1	77.1	77.1	77.1	77.1	0.0	neutral	
7	8/18/2023	77.1	1178.68	60 min	1238	1138	77.4	77.2	77.1	77.1	77.1	0.3	neutral	
8	8/18/2023	77.1	1178.68	60 min	1238	1138	77.4	77.2	77.1	77.1	77.1	0.3	neutral	
9	8/18/2023	77.8	1178.68	60 min	1408	1308	77.8	77.2	77.3	77.2	77.2	0.6	neutral	
10	8/18/2023	77.8	1178.68	60 min	1408	1308	77.8	77.2	77.3	77.2	77.2	0.6	neutral	
11	8/18/2023	77.6	1178.68	60 min	1450	1350	77.6	77.3	77.2	77.2	77.2	0.4	neutral	
12	8/18/2023	77.6	1178.68	60 min	1450	1350	77.6	77.3	77.2	77.2	77.2	0.4	neutral	
13	8/18/2023	87.2	1178.68	60 min	1456	1356	87.2	76.9	76.9	76.9	76.9	10.3	>+10	
14	8/18/2023	87.2	1178.68	60 min	1456	1356	87.2	76.9	76.9	76.9	76.9	10.3	>+10	
15	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral	vapor
16	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral	vapor
17	8/20/2023	87.6	1178.68	60 min	1721	1621	87.6	77.4	77.3	77.3	77.3	10.3	>+10	
18	8/20/2023	87.6	1178.68	60 min	1721	1621	87.6	77.4	77.3	77.3	77.3	10.3	>+10	
19	8/21/2023	58.5	1178.68	60 min	1325	1225	58.5	77.4	77.3	77.3	77.3	-18.8	<-10	
20	8/21/2023	58.5	1178.68	60 min	1325	1225	58.5	77.4	77.3	77.3	77.3	-18.8	<-10	
21	8/21/2023	65.0	1178.68	60 min	1500	1400	65.0	76.0	76.8	77.3	77.0	-12.0	<-10	

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category	
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)	
22	8/21/2023	65.0	1178.68	60 min	1500	1400	65.0	76.0	76.8	77.3	77.0	-12.0	<-10	
23	8/21/2023	65.8	1178.68	60 min	1608	1508	65.8	75.5	76.5	77.2	76.9	-11.1	<-10	
24	8/21/2023	65.8	1178.68	60 min	1608	1508	65.8	75.5	76.5	77.2	76.9	-11.1	<-10	
25	8/21/2023	66.5	1178.68	60 min	1735	1635	66.5	75.0	76.3	77.1	76.7	-10.2	<-10	
26	8/21/2023	66.5	1178.68	60 min	1735	1635	66.5	75.0	76.3	77.1	76.7	-10.2	<-10	
27	8/21/2023	65.9	1178.68	60 min	1900	1800	65.9	74.8	76.2	77.0	76.6	-10.7	<-10	
28	8/21/2023	65.9	1178.68	60 min	1900	1800	65.9	74.8	76.2	77.0	76.6	-10.7	<-10	
29	8/21/2023	65.9	1178.68	60 min	2045	1945	65.9	74.6	76.0	76.6	76.2	-10.3	<-10	
30	8/21/2023	65.9	1178.68	60 min	2045	1945	65.9	74.6	76.0	76.6	76.2	-10.3	<-10	
31	8/22/2023	61.5	1178.68	60 min	1252	1152	61.5	75.4	75.8	76.5	76.2	-14.7	<-10	
32	8/22/2023	61.5	1178.68	60 min	1252	1152	61.5	75.4	75.8	76.5	76.2	-14.7	<-10	
33	8/22/2023	72.0	1178.68	60 min	1401	1301	72.0	75.1	75.6	76.4	76.1	-4.1	neutral	vapor
34	8/23/2023	86.7	1178.68	60 min	1403	1303	86.7	76.4	76.6	76.7	76.6	10.1	>+10	
35	8/23/2023	86.7	1178.68	60 min	1403	1303	86.7	76.4	76.6	76.7	76.6	10.1	>+10	
36	8/24/2023	86.8	1178.68	60 min	1311	1211	86.8	76.6	76.5	76.5	76.5	10.3	>+10	
37	8/24/2023	86.8	1178.68	60 min	1311	1211	86.8	76.6	76.5	76.5	76.5	10.3	>+10	
38	8/24/2023	87.0	1178.68	60 min	1607	1507	87.0	77.7	77.0	76.5	76.7	10.3	>+10	
39	8/24/2023	87.0	1178.68	60 min	1607	1507	87.0	77.7	77.0	76.5	76.7	10.3	>+10	
40	8/25/2023	87.8	1178.68	60 min	1141	1041	87.8	77.2	77.0	77.0	77.0	10.8	>+10	
41	8/25/2023	87.8	1178.68	60 min	1141	1041	87.8	77.2	77.0	77.0	77.0	10.8	>+10	
42	8/25/2023	88.0	1178.68	60 min	1450	1350	88.0	78.0	77.4	77.1	77.3	10.7	>+10	
43	8/25/2023	88.0	1178.68	60 min	1450	1350	88.0	78.0	77.4	77.1	77.3	10.7	>+10	
44	8/25/2023	88.1	1178.68	60 min	1717	1617	88.1	78.6	77.7	77.2	77.5	10.6	>+10	
45	8/25/2023	88.1	1178.68	60 min	1717	1617	88.1	78.6	77.7	77.2	77.5	10.6	>+10	

Attachment 5

Hourly (3gal/h)

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

Veeder-Root BFX-1DV Pump Mounted - Diesel Fuel

Pipeline Release Detection Method *At a Test Facility*

Test No. (Based on Temperature Condition	Date Test Began	Induced Leak Rate	Time Circulation Ended	Time Between End of of Circulation and Start of Data Collection for Test	Time Data Collection Began	Time Data Collection Ended	Measured Test Result	Was Threshold Exceeded?	Test Duration for leak result tests	Test Duration for tight result tests	
	(D-M-Y)	(gal/hr)	(military)	(min)	(military)	(military)	(leak or tight)	(yes or no)	(seconds)	(seconds)	
1	8/16/2023	0	1306	0	1306	1607	tight	no		64	
2	8/16/2023	3	1306	1	1307	1312	leak	yes	300		
3	8/16/2023	0	1519	0	1519	1520	tight	no		59	
4	8/16/2023	3	1519	1	1520	1525	leak	yes	300		
5	8/18/2023	0	1105	0	1105	1106	tight	no		56	
6	8/18/2023	3	1105	1	1106	1111	leak	yes	300		
7	8/18/2023	0	1238	0	1238	1243	leak	yes	300		
8	8/18/2023	3	1238	1	1243	1244	tight	no		59	
9	8/18/2023	0	1408	0	1408	1409	tight	no		57	
10	8/18/2023	3	1408	1	1409	1414	leak	yes	300		
11	8/18/2023	0	1450	0	1450	1451	tight	no		59	
12	8/18/2023	3	1450	1	1451	1456	leak	yes	300		
13	8/18/2023	0	1456	0	1456	1457	tight	no		43	
14	8/18/2023	3	1456	1	1457	1502	leak	yes	300		
15	8/20/2023	0	1117	0	1117	1118	tight	no		38	vapor
16	8/20/2023	3	1117	1	1118	1123	leak	yes	300		vapor
17	8/20/2023	0	1721	0	1721	1722	tight	no		58	
18	8/20/2023	3	1721	1	1722	1727	leak	yes	300		
19	8/21/2023	0	1325	0	1325	1326	tight	no		64	
20	8/21/2023	3	1325	1	1326	1331	leak	yes	300		
21	8/21/2023	0	1500	0	1500	1501	tight	no		93	
22	8/21/2023	3	1500	1	1501	1506	leak	yes	300		
23	8/21/2023	0	1608	0	1608	1609	tight	no		27	
24	8/21/2023	3	1608	1	1609	1614	leak	yes	300		
25	8/21/2023	0	1735	0	1735	1736	tight	no		27	
26	8/21/2023	3	1735	1	1736	1741	leak	yes	300		
27	8/21/2023	0	1900	0	1900	1901	tight	no		28	
28	8/21/2023	3	1900	1	1901	1906	leak	yes	300		
29	8/21/2023	0	2045	0	2045	2046	tight	no		29	
30	8/21/2023	3	2045	1	2046	2051	leak	yes	300		
31	8/22/2023	0	1252	0	1252	1253	tight	no		21	
32	8/22/2023	3	1252	1	1253	1258	leak	yes	300		
33	8/22/2023	0	1401	0	1401	1402	tight	no		24	vapor
34	8/23/2023	0	1403	0	1403	1404	tight	no		61	
35	8/23/2023	3	1403	1	1404	1409	leak	yes	300		
36	8/24/2023	0	1311	0	1311	1312	tight	no		69	
37	8/24/2023	3	1311	1	1312	1317	leak	yes	300		
38	8/24/2023	0	1607	0	1607	1608	tight	no		33	
39	8/24/2023	3	1607	1	1608	1613	leak	yes	300		
40	8/25/2023	0	1141	0	1141	1142	tight	no		27	
41	8/25/2023	3	1141	1	1142	1147	leak	yes	300		
42	8/25/2023	0	1450	0	1450	1451	tight	no		28	
43	8/25/2023	3	1450	1	1451	1456	leak	yes	300		
44	8/25/2023	0	1717	0	1717	1718	tight	no		33	
45	8/25/2023	3	1717	1	1718	1723	leak	yes	300		

Attachment 6

Hourly (3.0 gal/hr)

Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Veeder-Root BFX-1DV Pump Mounted - Diesel Fuel

Pipeline Leak Detection System

Options 1 and 5

Summary of Temperature Conditions

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
15	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral
16	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral
33	8/22/2023	72.0	1178.68	60 min	1401	1301	72.0	75.1	75.6	76.4	76.1	-4.1	neutral

Summary of Leak Rates

Test No.	**Date Test Began**	**Pipeline Pressure**	**Induced Leak Rate**	**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-min)**	**(local military)**	**(local military)**	**(Tight or Leak)**	**(Yes or No)**
15	8/20/2023	30	0	0	1117	1118	Tight	No
16	8/20/2023	30	3	1	1118	1123	Leak	Yes
33	8/22/2023	30	0	0	1401	1402	Tight	No

Evaluation of the Veeder-Root BFX1DV Mechanical Pipeline Leak Detector, BFVD Manifold Mounted, for Hourly Testing on Rigid, Flexible and Hybrid Pipelines

Final Report Version 4

PREPARED FOR

Veeder-Root
125 Powder Forest Drive
Post Office Box 2003
Simsbury, Connecticut 06070-2003

November 10, 2023

Preface

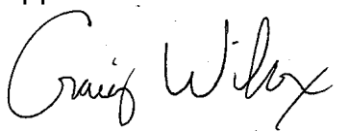
This report was prepared for Veeder-Root by Ken Wilcox Associates, Inc. This report presents the results of an independent performance evaluation of the Veeder-Root BFX1DV Mechanical Pipeline Leak Detector(MLLD) Mounted in a Veeder-Root Big Flow Valve Diaphragm (BFVD) Manifold for use on rigid, flexible, and combined pipelines.

This report covers the performance of the BFX1DV MLLD when mounted in the BFVD for Hourly (3gph) testing for pressurized piping. The purpose of the current testing is to show that the system performs adequately when tested on rigid, flexible as well as hybrid piping. Testing for this evaluation was performed in accordance with the US EPA protocol “Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection”, May 2019. The results indicate that the BFX1DV MLLD when mounted in the BFVD manifold will successfully detect a leak of 3gph on flexible, rigid and hybrid pipeline systems.

The work was conducted at the Fuels Management Research Center, which is operated by Ken Wilcox Associates, Inc. This report was prepared by Craig D Wilcox for, Ken Wilcox Associates, Inc. Technical Questions regarding this evaluation should be directed to the Veeder-Root Engineering Department at 860-651-2700.

November 10, 2023 KEN WILCOX ASSOCIATES, INC.

Approved:



Craig D Wilcox
President

Table of Contents

Executive Summary

This report presents the results of an independent evaluation of the BFX1DV MLLD when mounted in the BFVD manifold for hourly testing on flexible, rigid and combination pipelines. The test procedures used were those described in the US EPA protocol "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

The performance capabilities of the BFX1DV MLLD when mounted in the BFVD manifold were determined for Hourly Testing. The BFX1DV MLLD when mounted in the BFVD manifold met the US EPA performance standards for hourly pipeline leak detection systems which require a probability of detecting a leak of stated size be 95% or greater with a probability of false alarm (declaring a tight line to be leaking) of no more than 5%.

The BFX1DV MLLD when mounted in the BFVD manifold was tested on a pipeline consisting of rigid, semi-rigid and flexible pipe. The total line volume for hourly testing was 589.34 gallons of diesel fuel with a bulk modulus of 17,052 psi. The pipeline configuration used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the three line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex.

The formal results of the evaluation are reported on the Official EPA forms in Attachment A, B and C of this report.

1.0 Introduction

The federal Environmental Protection Agency (EPA) has provided a series of documents[1] that describe the procedures that are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.[2] At the minimum, a leak detector that is capable of detecting leaks of 3.0 gallons per hour (gal/hr) at 10 psi or larger on an hourly basis must be installed on all pressurized pipelines. The probability of detecting a leak of stated size must be 95% or greater with a probability of a false alarm (declaring a tight line to be leaking) of no more than 5%.

This report presents the results of an independent evaluation of the performance of the BFX1DV MLLD when mounted in the BFVD manifold for testing on rigid, semi-rigid, flexible and combined pipelines. The evaluation was conducted by Ken Wilcox Associates, Inc. at the Fuels Management Research Center in Grain Valley, Missouri. Testing for this evaluation was performed in accordance with the US EPA protocol "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

A total of 45 tests were conducted to verify that the leak detector could detect 3 gal/hr leaks on Flexible, Rigid and Hybrid pipelines containing diesel fuel. The results of this testing indicate that the BFX1DV MLLD when mounted in the BFVD manifold for testing on rigid, flexible, and combined pipelines will successfully perform Hourly Testing on Flexible, Rigid and Hybrid pipeline systems.

[1] "Standard Test Procedures For Evaluating Release Detection Methods: Pipeline Release Detection", May 2019.

[2] 40CFR Part 280, Subpart D.

2.0 Overview of Evaluation Procedures

A total of 45 tests were conducted for this evaluation on the BFX1DV MLLD when mounted in the BFVD manifold. The test conditions for these tests are provided in Table 3. Out of the 45 Hourly tests that were performed, 23 were run with no leak and 22 were run with a leak. Testing was conducted with temperature differentials between the ground and the fuel (that was circulated through the pipeline) at temperature three different temperature differentials including +10, 0 and -10 degrees Fahrenheit.

Testing was carried out using the manufacturer's normal test routine. The BFX1DV MLLD when mounted in the BFVD manifold was in the line in its usual configuration. The temperature of the product in the pipeline tank was varied relative to the surrounding soil temperature. Product was then circulated through the line for twice the line volume and leaks were induced at rates equivalent to 3 gal/h at 10 psi for the Hourly testing as specified in the US EPA protocol. Tests were also run with a zero leak rate; that is, with the line in the tight condition. The induced leak rates were established during the circulation period by introducing a controlled flow through a variable cross-sectional area flow meter.

Testing for this evaluation was performed in accordance with the US EPA protocol. The EPA test protocol requires that 21 leak tests, 21 tight tests and 3 tests with vapor present in the line to be conducted, for each of the hourly testing, with various temperature differentials between product in the line and the ground.

Briefly summarized, the test procedures were as follows:

1) Product was conditioned in the pipeline tank to the required temperature. The soil temperature was monitored throughout the entire test at distances of 2, 4, and 12 inches from the pipeline to determine proper temperature differentials.
2) Product was circulated through the pipeline at a rate of approximately 19.7 gal/min for twice the volume of the pipeline (60 minutes).
3) Flow in the line was stopped by closing the outlet valve while the submersible pump was still on. The pump was then turned off and the outlet valve opened to lower the pressure down to zero pressure(less than 1 psi).
4) For a test with a leak to be induced, a pre-calibrated leak was turned on with a leak equivalent to 3 gal/h at 10 psi.
5) The submersible turbine pump dispenser switch was then turned on and the leak detector conducted the test.
6) Steps 1 through 5 were repeated for every set of tests with both tight tests and induced leak tests.

3.0 Description of the Test Equipment

The Veeder-Root BFX1DV is a mechanical line leak detector. For this evaluation, the Veeder-Root BFX1DV was mounted in a BFVD manifold rather than a submersible turbine pump (STP). The BFX1DV mechanical line leak detector is designed to be permanently installed in the fuel line, and performs a 3 gal/h hourly test automatically. If a leak is detected by the BFX1DV, fuel flow is restricted to the dispensers. The BFX1DV sample used in this evaluation had a part # of 410983-001 and a serial # of 107235015. The pictures of the unit evaluated are shown in Image 1 thru 4.

Image 1

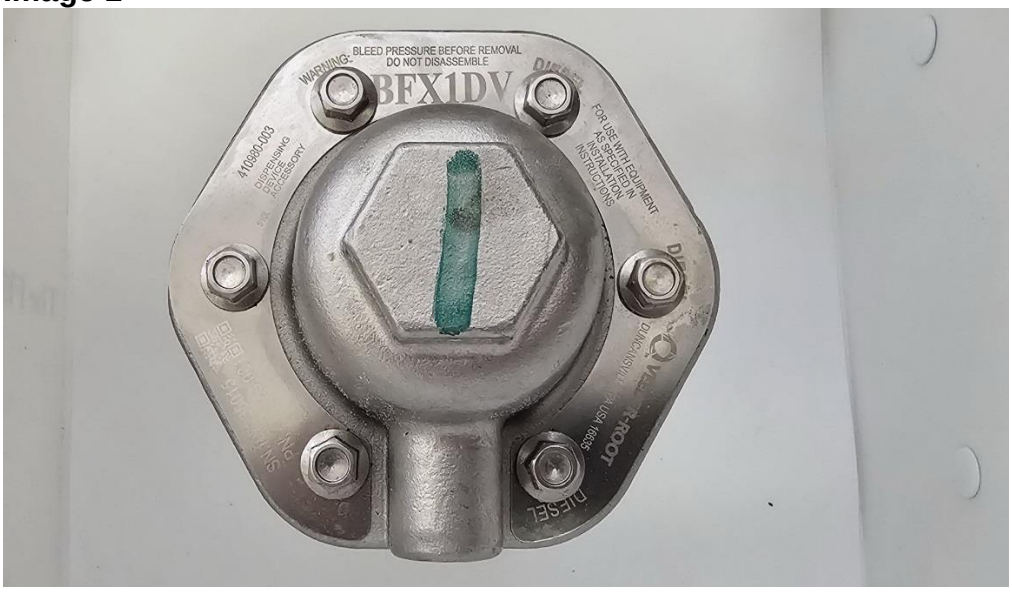


Image 2

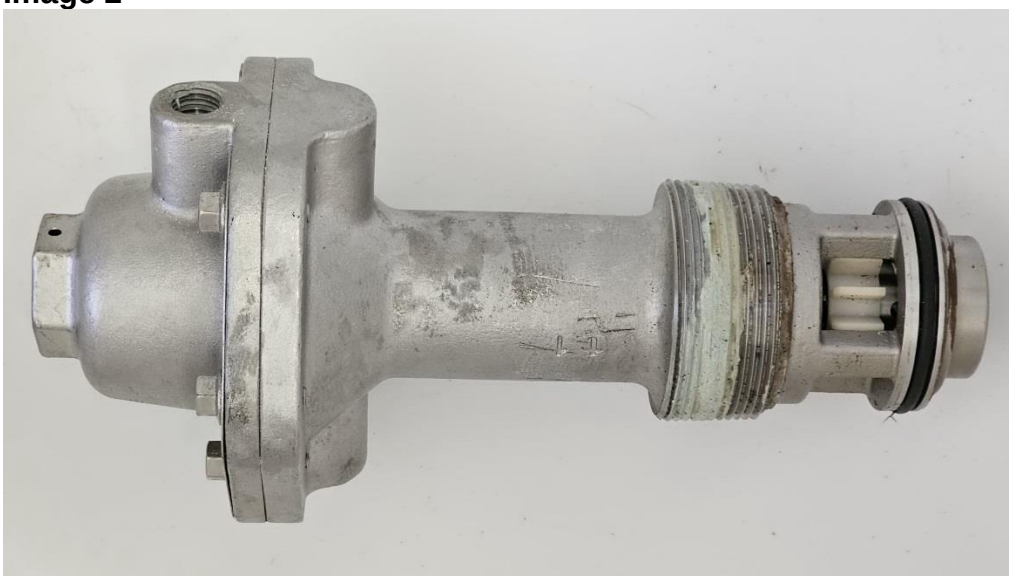


Image 3

Image 4

4.0 Description of the Testing Location

The BFX1DV MLLD, mounted in the BFVD manifold, was evaluated at the Fuels Management Research Center located in Grain Valley, Missouri, which is operated by Ken Wilcox Associates, Inc. Line tests described in this report were conducted on the combination of pipeline detailed in Table 1. Table 1 shows the pipeline configuration and product used, along with the volumes of the line combination. The bulk modulus, which is a measure of the "stretch" which occurs when the line is pressurized, is shown in Attachment 3. Details of the piping configuration used in the evaluation are included in table 1.

The conditioned product is contained in a 600 gallon steel tank, which is equipped with a standard Red Jacket submersible pump. Product is heated or cooled in the tank by circulating glycol and product through an external heat exchanger. Soil temperatures were monitored using RTDs, which were located at 2 inches, 4 inches and 12 inches from the line as specified by the EPA protocol. A single temperature probe was located 4 inches from the bottom of the product conditioning tank. The weighted soil temperature and the product tank temperature at the beginning of the test were used to compute the temperature differential.

Table 1. Pipeline Configurations Used for Hourly Testing

Segment	Construction	Length (ft)	Diameter (in)	Volume (gal)
1	FRP - single wall	34	3.125	13.55
2	FRP Double wall	200	4	130.38
3	FRP - single wall	40	3.125	16.45
4	Flex -double wall	34	1.5	3.12
5	Flex double wall	130	3.125	51.8
6	FRP - single wall	104	3.125	41.44
7	FRP - single wall	27	3.125	11.1
8	NUPI - TSMAXPD	1964	2	321.5
Total				589.34

Rigid Volume Used (segment 1,2,3,6,7) – 212.92 gallons
Semi-Rigid Volume Used (segment 8) – 321.5 gallons
Flex Volume Used (segment 4,5) – 54.92 gallons
Maximum Volume (2X evaluated) Allowable for Pipeline Testing = 1178.68 gallons
Bulk Modulus of combination line = 17,052 psi

5.0 Test Results and Discussion

The test results of the BFX1DV MLLD when mounted in the BFVD manifold were compared to the leak conditions induced in the line. Forty-five hourly tests were conducted using the procedures described in Section 2.0 of this report. For the hourly testing 22 of these tests were run with a 3 gal/h leak induced in the line and 23 were run with the line in the tight condition and 3 of these tests were performed with vapor in the line. During all of the hourly testing, the BFX1DV allowed the pipeline to open to full pressure (tight result) with the line in the tight condition and restricted flow (detected leak) during all tests with a 3 gal/hr leak induced. This detected leak or passing test by the BFX1DV MLLD was compared to the induced leak or no leak and the results are reported in Appendix B.

Testing was conducted using procedures specified in the US EPA protocol. For the hourly testing, the results of the evaluation have been calculated using Section 5.2 of the US EPA procedures for systems that do not report a leak rate. The results of the data analysis have been summarized in Table 3. The pipeline configuration is described more completely using the EPA Pipeline Protocol Attachment 3 reported as Table 3. The test data for this evaluation are contained in Attachment 4 and 5 and 6, which correspond to Attachments 4, 5 and 6 of the US EPA Protocol.

Calculation of P_{FA} and P_D

Since the BFX1DV MLLD hourly tests are a pass/fail system, the calculation of the Probability of Detection (P_D) and the Probability of False Alarm (P_{FA}) was based on the number of correct test results compared to the number of tests of that type. For these standards, the statistics for estimating P_{FA} and P_D were based on the calculations found in Section 5.21 and 5.22 of the pipeline protocol.

Performance for Hourly (3.0 gal/hr) Testing

A total of 45 tests (23 tight and 22 with induced leaks) were conducted for the system. A total of 3 tests (2 tight and 1 with an induced leak) with trapped vapor were conducted for the system. There were no missed detections or false alarms observed for these 45 tests. Forty-five tests were conducted on the system including the three tests with trapped vapor. The P_D and P_{FA} were calculated by dividing the number of correct results by the total number of such tests that were conducted. Since there were no false alarms or missed detections using the hourly test, the estimated P_{FA} was 0% and the estimated P_D was 100%. Since one cannot assume that a qualitative method would never make a mistake only based on about 45 tests, a 95% confidence limit was calculated for each parameter. Based on these calculations, one can be 95% confident that the P_{FA} is between 0% and 12.73%, while the 95% confidence limit for P_D is from 87.79% to 100%. The tests that were performed without a leak induced, ranged from 45 seconds to 180 seconds with an average test time of 82 seconds. The test was determined as tight at the moment when the leak detector opened and allowed full

pressure to the pipeline. For each of the tests with a 3 gal/h leak induced, the BFX1DV leak detector restricted the flow to the pipeline and held the pressure at a lower PSI for the full 5 minute duration. After 5 minutes of restricted flow, the test was declared and recorded as a leak result. It is important to note that the 5 minute test time was a KWA selected maximum time to allow for the leak detector to open (passing result) or remain in restricted flow (leak result) for all tests.

Maximum Line Size for Hourly Testing

The EPA allows for line leak detectors to be used on lines up to twice the volume that they were evaluated on. In this evaluation the lines were a total of 2533 feet in length. The volume of the line configuration was 589.34 gallons. The pipeline used in the evaluation consisted of rigid, semi-rigid and flexible pipelines. The volume for each of the 3 line types were 212.92 gallons for rigid, 321.5 gallons for semi-rigid and 54.92 gallons for flex. Thus, if the EPA allowance is applied to these tests of twice the volume evaluated, the BFX1DV MLLD, when mounted in an STP, for hourly testing can be used on lines up to a total volume of 1178.68 gallons.

Waiting Times

Waiting times after the delivery of product, after product is circulated through the line or after pumping has stopped are not necessary before valid tests can be conducted. For the Hourly testing, 2 tests were run after each circulation. As a result, the waiting times for the hourly testing ranged from 0 minutes to 25 minutes, with an average of 3.4 minutes.

Table 3. Performance Parameters for the Veeder-Root BFX1DV Mechanical line Leak Detector with BFVD manifold for Flexible, Rigid, and Hybrid Pipelines Using the EPA Protocol

Parameter	Value
Probability of Detection (P_D) of a 3.0 gal/hr leak (Hourly)	100% (87.79% to 100%)
Probability of False Alarm (Hourly P_{FA})	0% (0% to 12.73%)
Maximum Line Size	Combination of all piping, flexible or rigid or in combination limited to a total capacity of 1178.68 gal. for hourly testing
Waiting Time after Delivery of Product before Conducting a Test	None Required
Waiting Time after Product Circulation Through Line before Conducting a Test	None Required
Hourly Test Times with a 3.0 gal/hr Leak	Range: 5 minutes
Hourly Test Times without Leak	Range: 45 to 180 seconds

6.0 Conclusions

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

- The observed P_D for a 3.0 gal/h leak was 100% and the P_{FA} on a tight line was 0.0%.
- Using the EPA protocol, the BFX1DV MLLD, when mounted in the BFVD manifold, can be used on any pipeline for hourly testing up to 1178.68 gallons in volume including rigid, flexible or a combination of pipeline types.
- A waiting time after product is circulated through the line or after pumping has stopped is not necessary before conducting a valid test.
- A waiting time after delivery of product is not necessary before a valid test can be conducted.

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

Options 1, 2, and 5

Pipeline Leak Detection System for Annual, Monthly and Hourly Testing

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.) [1]	Range from 1.5 in to 4 in*
Length of pipeline (tank to dispenser) (ft) [2]	Rigid – 405ft Semi-Rigid – 1964ft Flex - 164ft **Total Length - 2533 ft**
Volume of product in line during testing (gal) [3]	Rigid – 212.92 gal Semi-Rigid – 321.5 gal Flex – 54.92 gal **Total Volume - 589.34 gal**
Type of material (fiberglass, steel, other[4])	Rigid (FRP), Semi-Rigid and Flex
Type of product in tank and pipeline (gasoline, diesel, other[5])	#2 Diesel fuel
Was a mechanical line leak detector present? (yes or no)	No
Was trapped vapor present? (yes or no)	yes
Bulk Modulus (B) (psi)	17,052 psi
B/V (psi/ml)	0.0077 psi/ml
Storage tank capacity (gal)	600 gal

[1]Specify for each section of pipe, if different.
[2]Specify length of each section of pipe, if different size or material.
[3]Specify volume for each section of pipe, if different size or type.
[4]Specify type of construction material for each pipe section.
[5]Specify type of product for each tank.

APENDIX A

Hourly (3 gal/h) Results and Attachments

Results Of U.S. EPA Standard Evaluation
Pipeline Release Detection Method

Hourly Test

This form summarizes the results of an evaluation to determine whether the pipeline release detection method named below and described in Attachment 1 complies with the federal UST regulation for conducting an hourly test. The evaluation was conducted according to the U.S. EPA's evaluation procedures, specified in *Standard Test Procedures for Evaluating Release Detection Methods: Pipeline Release Detection*. The full evaluation report includes six attachments.

UST system owners and operators who use this pipeline release detection method should keep this form on file to show compliance with the federal UST regulation. UST system owners and operators should check with state and local regulatory authorities to make sure this form satisfies the requirements of their agencies.

Method Evaluated

Method Name: BFX1DV Mechanical Line Leak Detector

Version of Method: BFX1DV MLLD when mounted in the BFVD manifold

Version of System: BFX1DV

Manufacturer Name: Veeder-Root

125 Powder Forest Drive
(street address)

Simsbury, CT 06070 (860) 651-2700
(city, state, zip code) (Phone number)

Evaluation Results

1. The performance of this method
   X meets or exceeds
   __ does not meet the federal standards established by the EPA regulation for hourly tests.

   The EPA regulation for an hourly test requires that the method be capable of detecting a leak as small as 3.0 gal/hr 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 3.0 gal/hr defined at a pipeline pressure of 10 psi in this evaluation is 100 %.

Criterion for Declaring a Leak

3. This method
   __uses a preset threshold
   __ measures and reports the output quantity and compares it to a predetermined threshold to determine whether the pipeline is leaking.
   _X_ Other The BFX1DV is a mechanical line leak detector. If a 3gal/hr leak is present, the BFX1DV will restrict the flow of fuel. If there is no leak present, the leak detector will open up and will allow for the maximum flow of fuel that is produced by the submersible turbine pump.

4. This method
   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 method declares a leak if the output of the measurement method exceeds a threshold of 3.0 gallon per hour (specify flow rate in gal/hr) in 1 out of 1 tests (specify, for example, 1 out of 2, 2 out of 3). Please give additional details, if necessary, in the space provided.

Evaluation Approach

6. A total of 23 tests were conducted on non-leaking tank(s) between 07/28/2023 ___(date) and 08/22/2023___ (date). A description of the pipeline configuration used in the evaluation is given in Attachment 3.

7. The pipeline used in the evaluation was_between 1.5 and 4_ in. in diameter, 2533ft long and constructed of__rigid(FRP), semi-rigid and flex____(fiberglass, steel, or other).

8. A mechanical line leak detector
   __ was
   X was not present in the pipeline system.

9. The evaluation was conducted on 1 (how many) pipeline systems ranging in diameter from 1.5___ in. to_4_in., ranging in length from_____2533__ft to 2533_____ft, and constructed of_rigid(FRP), semi-rigid and flex_(specify materials).

10. Please specify how much time elapsed between the delivery of product and the start of the data collection:
    X 0 to 6 hr
    __6 to 12 hr
    __12 to 24
    __hr >24 hr

Data Used to Make Performance Estimates

11. The induced leak rate and the test results used to estimate the performance of this method 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

12. _X_ According to the vendor, this method can be used even if trapped vapor is present in the pipeline during a test.
___ According to the vendor, this method *should not be used* if trapped vapor is present in the pipeline.

13. The sensitivity of this method to trapped vapor is indicated by the test results summarized in Table 1. These tests were conducted at 30 psi with 500 mL of vapor trapped in the line at a pressure of 0 psi. The data and test conditions are reported in Attachment 6.

Table 1. Summary of the Results of Trapped Vapor Tests

Test No.	ΔT (°F)	Induced Leak Rate (gal/hr)	Measured Leak Rate (tight/leak)
43	1.1	0	tight
44	1.1	3	leak
45	-10.7	0	tight

Application of the Method

16. This release detection method 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, steel, or other and that typically measure 2 in. in diameter and 150 ft or less in length. The performance estimates are valid when:

- the method that was evaluated has not been substantially changed by subsequent modifications
- the vendor's instructions for using the method are followed
- a 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 hr
- the waiting time between the last dispensing of product through the pipeline system and the start of data collection for the test is 0 hr
- the total data collection time for the test is between 45 seconds and 5 minutes
- the volume of the product in the pipeline system is less than twice the volume of the product in the pipeline system used in the evaluation, unless a separate written justification for testing larger pipeline systems is presented by the vendor, concurred with by the evaluator, and included with this evaluation as an additional attachment.
- give any other limitations specified by the vendor or determined during the evaluation: _____

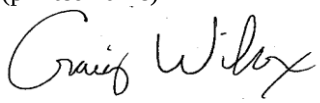
Attachments

Attachment 1 - Description of the Method Evaluated
Attachment 2 - Summary of the Performance of the Method 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

Certification of Results

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

Craig Wilcox
(printed name)



(signature)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Grain Valley, Missouri 64029
(city, state, zip)

November 10, 2023
(date)

(816) 443-2494
(phone number)

Attachment 1
Description

Pipeline Release Detection Method

The evaluator, with help from the vendor, fills out this form prior to the start of the evaluation. This form provides a description of the method and how it works. It should be filled out completely – check all appropriate boxes for each question. If *other* is checked, provide a description. For those answers dependent on site conditions, give answers that apply in typical conditions. This form is to be filled out by the evaluator with assistance from the vendor before the start of the evaluation. Describe the important features of the method as indicated below. A detailed description is not required, nor is it necessary to reveal proprietary features of the system.

Method Name and Version: _____

Date: _____

Applicability of the Method

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

   _gasoline
   X diesel
   _aviation fuel
   _fuel oil #4
   _fuel oil #6
   _solvent
   _waste oil
   _ other (specify) _____

2. What types of pipelines can be tested? (Check all applicable responses.)
   X fiberglass
   X steel
   X other (specify) This system can be used on any pipeline type including rigid, flex and semi-rigid

3. Can this release detection method be used to test double-wall pipeline systems?
   X yes(primary pipe) ☐ no

4. What is the nominal diameter of a pipeline that can be tested with this method?
   __1 in. or less
   X between 1 and 3 in.
   X between 3 and 6 in.
   __between 6 and 10 in.
   other _____

5. The method can be used on pipelines pressurized to _50_ psi

   The safe maximum operating pressure for this method is _200__ psi.

6. Does the method conduct a test while a mechanical line leak detector is in place in the pipeline?
   X Not applicable - The BFX1DV is a mechanical line leak detector

General Features of the Method

7. What type of test is the method conducting? (Check all applicable responses.)
   __0.10 gal/hr Line Tightness Test
   __0.20 gal/hr Monthly Monitoring
   X_ 3 gal/hr Hourly

8. Is the method permanently installed on the pipeline?
   X yes ☐ no

   Does the method test the line automatically?
   X yes ☐ no

If a leak is declared, what does the method do? (Check all applicable responses.)
__ displays or prints a message
__ triggers an alarm
__ programmable alerts via Ethernet, serial, SMS, email-mail or internet
X Restricts the flow of fuel and does not allow for full pressure on the line past the leak detector

9. What quantity or quantities are measured by the method? (Please list.)

   This leak detector is a mechanical line leak detector. The leak detector detects if there is a 3 gal/hr or greater leak in the pipeline beyond the point where the leak detector installed.

10. Does the method 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 method 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?
    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 release detection test?
    X no waiting
    __period less than 15
    __min 15 min to 1 hr
    __1 to 5 hr
    __6 to 12 hr
    __12 to 24 hr greater
    __than 24 hr
    __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 release detection test?

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

15. What is the minimum amount of time necessary to set up equipment and complete a release 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.)
The test duration for this evaluation ranged from 45 seconds to 180 seconds for a tight test and 5 minutes for a test with a leak. The average time for a tight test was 82 seconds for the MLLD to open(pass) on a 589.34 gallon line as evaluated. For tests with a leak induced, the test duration was 5 minutes. The BFX1DV MLLD remained in the restricted flow(leak detected) for the full duration of the 5 minute test (single test).
not applicable hr (multiple test)

16. Does the method compensate for those pressure or volume changes of the product in the pipeline that are due to temperature changes?
_ yes 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?
X no ☐ yes___

_____

_____

If yes, briefly specify:

21. Are elements of the test procedures determined by on-site testing 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
X other (Describe briefly.) _____

Data Acquisition

22. How are the test data acquired and recorded?

__ manually
__ by strip
__chart by
__computer
X This is a mechanical line leak detector, no data is acquired or recorded

23. Certain calculations are necessary to reduce and analyze the data. How are these calculations done?
__ manual calculations by the evaluator on site
__interactive computer program used by the
__automatically done with computer program
X This is a mechanical line leak detector, no data is acquired or recorded

Detection Criterion

24. What threshold is used to determine whether the pipeline is leaking?
Not applicable – this is an MLLD (in the units used by the measurement system)
Not applicable – this is an MLLD (in gal/hr)

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 3 questions below)

X no

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?
X never
__before each test
__weekly monthly
__semi-annually
__yearly or less frequently

Attachment 2
Summary Of Performance Estimates

Pipeline Release Detection Method
Hourly Test
First Test Of A Multiple-Test Sequence

Complete this page only if the method being evaluated requires, as part of its test procedures, more than one complete test to determine whether the pipeline is leaking. Method performance based on the first test alone must be reported on this form. Complete the first table. The last three tables present the performance of the method for different combinations of thresholds, probabilities of false alarm, and probabilities of detection. They are useful for comparing the performance of this method to that of other methods. However, completion of the last three tables is optional.

Performance Of The Pipeline Release Detection Method As Evaluated

Description	Leak Rate (gal/hr)	P(d)	P(fa)	Threshold (gal/hr)
Evaluated Method	3.0	100%	0%	N/A
EPA Standard	3.0	0.95	0.05	N/A

P(fa) As A Function Of Threshold

Threshold (gal/hr)	P(fa)
	0.10
	0.075
	0.05
	0.05

P(d) As A Function Of Threshold For A Leak Rate Of 3.0 gal/hr

Threshold (gal/hr)	P(d)
	0.95
	0.90
	0.80
	0.50

Smallest Leak Rate That Can Be Detected With The Specified P(d) and P(fa)

Leak Rate (gal/hr)	P(d)	P(fa)
	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)

Complete these tables to identify the configuration of the pipeline system.

Pipeline Release Detection Method At Test Facility Or Retail Station

Specialized Test Facility Or Operational UST Facility	
Inside diameter of pipeline (in.)	1.5" to 4"
Length of pipeline (tank to dispenser) (ft)	2533'
Volume of product in line during testing (gal)	589.34
Type of material (fiberglass, steel, other*)	Fiberglass, Flex and Semi-Rigid
Type of product in tank and pipeline (gasoline, diesel, other**)	Diesel #2
Was a mechanical line leak detector present? (yes or no)	No
Was trapped vapor present? (yes or no)	No
Compressibility (C) (psi)	17,052
C/Vo (psi/gal)	0.0077 psi/ml
Storage tank capacity (gal)	600

* Specify type of construction material.

Attachment 4
Hourly(3 gal/h) Tests
Data Sheet Summarizing the Product Temperature Conditions Used in the Evaluation
Veeder-Root BFX-1DV mounted in BFVD manifold - Diesel Fuel
Pipeline Leak Detection Systems
Options 1 and 5

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
1	7/28/2023	60.6	1178.68	60 min	1520	1420	60.6	72.9	75.1	75.9	75.4	-14.8	<-10
2	7/28/2023	60.6	1178.68	60 min	1520	1420	60.6	72.9	75.1	75.9	75.4	-14.8	<-10
3	8/6/2023	65.3	1178.68	60 min	1900	1800	65.3	75.5	75.5	75.5	75.5	-10.2	<-10
4	8/6/2023	65.3	1178.68	60 min	1900	1800	65.3	75.5	75.5	75.5	75.5	-10.2	<-10
5	8/7/2023	69.9	1178.68	60 min	1523	1423	69.9	75.0	75.3	75.7	75.5	-5.6	neutral
6	8/7/2023	69.9	1178.68	60 min	1523	1423	69.9	75.0	75.3	75.7	75.5	-5.6	neutral
7	8/7/2023	70.4	1178.68	60 min	1703	1603	70.4	74.8	75.2	75.7	75.5	-5.1	neutral
8	8/7/2023	70.4	1178.68	60 min	1703	1603	70.4	74.8	75.2	75.7	75.5	-5.1	neutral
9	8/8/2023	89.5	1178.68	60 min	1257	1157	89.5	75.1	75.1	75.1	75.1	14.4	>+10
10	8/8/2023	89.5	1178.68	60 min	1257	1157	89.5	75.1	75.1	75.1	75.1	14.4	>+10
11	8/8/2023	86.5	1178.68	60 min	1523	1423	86.5	77.8	75.7	75.5	75.8	10.7	>+10
12	8/8/2023	86.5	1178.68	60 min	1523	1423	86.5	77.8	75.7	75.5	75.8	10.7	>+10
13	8/8/2023	86.5	1178.68	60 min	1646	1546	86.5	78.9	76.7	75.7	76.3	10.2	>+10
14	8/8/2023	86.5	1178.68	60 min	1646	1546	86.5	78.9	76.7	75.7	76.3	10.2	>+10
15	8/9/2023	76.3	1178.68	60 min	1000	0900	76.3	76.5	76.3	76.2	76.3	0.0	neutral
16	8/9/2023	76.3	1178.68	60 min	1000	0900	76.3	76.5	76.3	76.2	76.3	0.0	neutral
17	8/9/2023	101.3	1178.68	60 min	1139	1039	101.3	76.4	76.3	76.2	76.2	25.1	>+10
18	8/9/2023	101.3	1178.68	60 min	1139	1039	101.3	76.4	76.3	76.2	76.2	25.1	>+10
19	8/9/2023	91.8	1178.68	60 min	1256	1156	91.8	79.1	76.6	76.2	76.6	15.2	>+10
20	8/9/2023	91.8	1178.68	60 min	1256	1156	91.8	79.1	76.6	76.2	76.6	15.2	>+10
21	8/9/2023	92.8	1178.68	60 min	1442	1342	92.8	79.9	77.2	76.2	76.8	16.0	>+10

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category	
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)	
22	8/9/2023	92.8	1178.68	60 min	1442	1342	92.8	79.9	77.2	76.2	76.8	16.0	>+10	
23	8/9/2023	92.8	1178.68	60 min	1557	1457	92.8	81.2	77.9	76.3	77.2	15.6	>+10	
24	8/9/2023	92.8	1178.68	60 min	1557	1457	92.8	81.2	77.9	76.3	77.2	15.6	>+10	
25	8/9/2023	83.0	1178.68	60 min	1756	1656	83.0	81.5	78.7	76.5	77.5	5.5	neutral	
26	8/9/2023	83.0	1178.68	60 min	1756	1656	83.0	81.5	78.7	76.5	77.5	5.5	neutral	
27	8/10/2023	81.0	1178.68	60 min	1320	1220	81.0	77.3	77.1	76.9	77.0	4.0	neutral	
28	8/10/2023	81.0	1178.68	60 min	1320	1220	81.0	77.3	77.1	76.9	77.0	4.0	neutral	
29	8/10/2023	81.8	1178.68	60 min	1427	1327	81.8	77.3	77.1	76.9	77.0	4.8	neutral	
30	8/10/2023	81.8	1178.68	60 min	1427	1327	81.8	77.3	77.1	76.9	77.0	4.8	neutral	
31	8/10/2023	78.3	1178.68	60 min	1535	1435	78.3	77.4	77.1	76.9	77.0	1.3	neutral	
32	8/10/2023	78.3	1178.68	60 min	1535	1435	78.3	77.4	77.1	76.9	77.0	1.3	neutral	
33	8/10/2023	50.3	1178.68	60 min	1756	1656	50.3	77.4	77.1	76.8	76.9	-26.6	<-10	
34	8/10/2023	50.3	1178.68	60 min	1756	1656	50.3	77.4	77.1	76.8	76.9	-26.6	<-10	
35	8/10/2023	60.9	1178.68	60 min	1930	1830	60.9	75.9	76.9	76.9	76.8	-15.9	<-10	
36	8/10/2023	60.9	1178.68	60 min	1930	1830	60.9	75.9	76.9	76.9	76.8	-15.9	<-10	
37	8/11/2023	60.1	1178.68	60 min	1050	0950	60.1	75.8	76.0	76.2	76.1	-16.0	<-10	
38	8/11/2023	60.1	1178.68	60 min	1050	0950	60.1	75.8	76.0	76.2	76.1	-16.0	<-10	
39	8/11/2023	56.8	1178.68	60 min	1325	1225	56.8	75.0	75.8	76.2	76.0	-19.2	<-10	
40	8/11/2023	56.8	1178.68	60 min	1325	1225	56.8	75.0	75.8	76.2	76.0	-19.2	<-10	
41	8/16/2023	65.0	1178.68	60 min	1900	1800	65.0	76.8	76.8	76.9	76.9	-11.9	<-10	
42	8/16/2023	65.0	1178.68	60 min	1900	1800	65.0	76.8	76.8	76.9	76.9	-11.9	<-10	
43	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral	vapor
44	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral	vapor
45	8/21/2023	65.9	1178.68	60 min	2045	1945	65.9	74.8	76.2	77.0	76.6	-10.7	<-10	vapor

Attachment 5

Hourly (3gal/h)

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

Veeder-Root BFX-1DV mounted in BFVD manifold - Diesel Fuel

Pipeline Release Detection Method *At a Test Facility*

Test No. (Based on Temperature Condition	Date Test Began	Induced Leak Rate	Time Circulation Ended	Time Between End of of Circulation and Start of Data Collection for Test	Time Data Collection Began	Time Data Collection Ended	Measured Test Result	Was Threshold Exceeded?	Test Duration for leak result tests	Test Duration for tight result tests	
	(D-M-Y)	(gal/hr)	(military)	(min)	(military)	(military)	(leak or tight)	(yes or no)	(seconds)	(seconds)	
1	7/28/2023	0	1520	0	1520	1522	tight	no		105	
2	7/28/2023	3	1520	2	1522	1527	leak	yes	300		
3	8/6/2023	3	1900	0	1900	1905	leak	yes	300		
4	8/6/2023	3	1900	5	1905	1910	leak	yes	300		
5	8/7/2023	3	1523	0	1523	1528	leak	yes	300		
6	8/7/2023	0	1523	5	1528	1529	tight	no		55	
7	8/7/2023	0	1703	1	1704	1705	tight	no		67	
8	8/7/2023	3	1703	2	1705	1710	leak	yes	300		
9	8/8/2023	3	1257	0	1257	1302	leak	yes	300		
10	8/8/2023	0	1257	10	1307	1310	tight	no		180	
11	8/8/2023	0	1523	0	1523	1524	tight	no		58	
12	8/8/2023	0	1523	2	1525	1530	leak	yes	300		
13	8/8/2023	0	1646	0	1646	1647	tight	no		78	
14	8/8/2023	3	1646	2	1648	1653	leak	yes	300		
15	8/9/2023	3	1000	0	1000	1005	leak	yes	300		
16	8/9/2023	0	1000	10	1010	1011	tight	no		75	
17	8/9/2023	3	1139	0	1139	1144	leak	yes	300		
18	8/9/2023	0	1139	9	1148	1151	tight	no		175	
19	8/9/2023	3	1256	0	1256	1301	leak	yes	300		
20	8/9/2023	0	1256	5	1301	1303	tight	no		130	
21	8/9/2023	3	1442	0	1442	1447	leak	yes	300		
22	8/9/2023	0	1442	5	1447	1450	tight	no		155	
23	8/9/2023	3	1557	0	1557	1602	leak	yes	300		
24	8/9/2023	0	1557	5	1602	1604	tight	no		93	
25	8/9/2023	0	1756	23	1819	1820	tight	no		66	
26	8/9/2023	3	1756	25	1821	1826	leak	yes	300		
27	8/10/2023	3	1320	0	1320	1325	leak	yes	300		
28	8/10/2023	0	1320	5	1325	1326	tight	no		63	
29	8/10/2023	3	1427	0	1427	1432	leak	yes	300		
30	8/10/2023	0	1427	5	1432	1433	tight	no		73	
31	8/10/2023	3	1535	0	1535	1540	leak	yes	300		
32	8/10/2023	0	1535	5	1540	1541	tight	no		77	
33	8/10/2023	0	1756	0	1756	1757	tight	no		55	
34	8/10/2023	3	1756	1	1757	1802	leak	yes	300		
35	8/10/2023	0	1930	0	1930	1931	tight	no		51	
36	8/10/2023	3	1930	2	1932	1937	leak	yes	300		
37	8/11/2023	3	1050	0	1050	1055	leak	yes	300		
38	8/11/2023	0	1050	5	1055	1056	tight	no		50	
39	8/11/2023	0	1325	0	1325	1326	tight	no		45	
40	8/11/2023	3	1325	1	1326	1331	leak	yes	300		
41	8/16/2023	0	1900	0	1900	1901	tight	no		54	
42	8/16/2023	3	1900	1	1901	1906	leak	yes	300		
43	8/20/2023	0	1117	6	1123	1124	tight	no		57	vapor
44	8/20/2023	3	1117	7	1124	1129	leak	yes	300		vapor
45	8/21/2023	0	2045	6	2051	2052	tight	no		50	vapor

Attachment 6

Hourly (3.0 gal/hr)

Data Sheet Summarizing the Test Results and the Trapped Vapor Tests

Veeder-Root BFX-1DV mounted in BFVD manifold - Diesel Fuel

Pipeline Leak Detection System

Options 1 and 5

Summary of Temperature Conditions

Test No.	Date Test Began	Nominal Product Temperature Before Circulation Was Started	Two Times Replacement of Volume in Piping	Duration of Circulation	Time Circulation Ended	Time of Temperature Measurements	T(TB)	T(1)	T(2)	T(3)	T(G)	T(TB)-T(G)	Temperature Test Matrix Category
	(D-M-Y)	(deg F)	(gallons)	(min)	(military)	(military)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(deg F)	(Table 5.1)
43	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral
44	8/20/2023	78.1	1178.68	60 min	1117	1017	78.1	77.1	77.1	77.0	77.0	1.1	neutral
45	8/21/2023	65.9	1178.68	60 min	2045	1945	65.9	74.8	76.2	77.0	76.6	-10.7	<-10

Summary of Leak Rates

Test No.	Date Test Began	Pipeline Pressure	Induced Leak Rate	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-min)	(local military)	(local military)	(Tight or Leak)	(Yes or No)
43	8/20/2023	30	0	6 min	1123	1124	Tight	No
44	8/20/2023	30	3	7 min	1124	1129	Leak	Yes
45	8/21/2023	30	0	6 min	2051	2052	Tight	No

VEEDER-ROOT™

For technical support, sales or other assistance, please visit:
veeder.com