Evaluation of the Red Jacket Fx1, Fx2, Fx1V and Fx2V Line Leak Detectors For Hourly Monitoring on Rigid Pipelines

Final Report

PREPARED FOR:

Marley Pump

a United Dominion Company

March 14, 1994

(Revised July 24, 1995)

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5800 Foxridge Drive
Mission, Kansas 66202

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Preface

The data contained in this report was obtained from the Red Jacket Fx1 and Fx2 Line Leak Detectors. This evaluation can be applied to the Fx1, Fx2, Fx1V, and Fx2V Line Leak Detectors. The test results are based on data collected using the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Pipeline Leak Detection Systems", EPA/530/UST-90/010. The work was conducted at the Leak Detection Test Center which is operated by Ken Wilcox Associates, Inc. Questions regarding this report should be directed to Mr. Klaus Jarr, Marley Pump Company, at (913) 831-5700.

KEN WILCOX ASSOCIATES, Inc.

H. Kendall Wilcox, President
March 14, 1994
(Revised July 24, 1995)

Attachment A

EPA Forms for the Red Jacket Fx1, Fx2, Fx1V, and Fx2V Line Leak Detectors for Hourly Testing 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

System Name: Red Jacket Fx Line Leak Detectors

Version of System: Fx1, Fx2, Fx1V, and Fx2V

Manufacturer Name: The Marley Pump Company

5800 Foxridge Drive
(street address)

Mission, Kansas 66202
(city, state, zip code)

(913) 831-5700
(telephone number)

Evaluation Results

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

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

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

Criterion for Declaring a Leak

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

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

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

   _____

Evaluation Approach

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

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

7. A total of 53 tests were conducted on nonleaking tank(s) between 10/6/93 (date) and 10/12/93 (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, 350 ft long and constructed of fiberglass (fiberglass, steel, or other).

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

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

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

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

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

Temperature Conditions

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

Table 1. Summary of Temperature Conditions Used in the Evaluation

Minimum Number of Conditions Required	Number of Conditions Used*	Range of) T(EF)**
1	2	) T < -25
4	8	-25 ≤) T < -15
5	10	-15 ≤) T < -5
5	10	-5 ≤) T < +5
5	10	+5 ≤) T < +15
4	8	+15 ≤) T < +25
1	2	) T > 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 8-12 psi with 110 ml of vapor trapped in the line at a pressure of 0 psi. The data and test conditions are reported in Attachment 6.

Table 2. Summary of the Results of Trapped Vapor Tests

Test No.	) T (EF)	Induced Leak Rate (gal/h @ 10 psi)	Measured Leak Rate (gal/h)
1	-3.84	3.25	Leak Detected
2	-3.84	0.00	Tight
3	-3.84	2.74	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:	0.01 deg F	1%	10
Response Time:	2 min	N/A	10

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

Application of the System

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

- the system that was evaluated has not been substantially changed by subsequent modifications
- the manufacturer's instructions for using the system are followed
- the mechanical line leak detector
(X) is present in
( ) has been removed from
the pipeline (check both if appropriate)
- the waiting time between the last delivery of product to the underground storage tank and the start of data collection for the test is 0 h

- the waiting time between the last dispensing of product through the pipeline system and the start of data collection for the test is 0 h

- the total data collection time for the test is < 5 min

- the volume of the product in the pipeline is less than twice the volume of the product in the pipeline system using in the evaluation, unless separate written justification for testing larger pipeline systems is presented by the manufacturer, concurred with by the evaluator, and attached to this evaluation as Attachment 8.

- please give any other limitations specified by the vendor or determined during the evaluation: Stabilization time up to 45 minutes after dispensing may be required when temperature extremes are present.

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

Attachments

Attachment 1 - Description of the System Evaluated

Attachment 2 - Summary of the Performance of the System Evaluated

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

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

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

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

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

Certification of Results

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

H. Kendall Wilcox, President
(printed name)

(signature)

March 14, 1994 (Revised July 24, 1995)
(date)

(816) 443-2494
(telephone number)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

1125 Valley Ridge Drive
(street address)

Grain Valley, MO 64029
(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: Red Jacket Fx1, Fx2, Fx1V and Fx2V Line Leak Detectors
Date: March 14, 1994 (Revised July 24, 1995)

Applicability of the System

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

   (X) gasoline
   (X) diesel
   (X) aviation fuel
   ( ) fuel oil #4
   ( ) fuel oil #6
   (X) solvent (per manufacturer's approval)
   ( ) waste oil
   (X) other (specify) Contact Manufacturer

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

   (X) fiberglass
   (X) steel
   (X) other (specify) Rigid piping with bulk modulus typically greater than 20,000 psi.

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?

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

5. The system can be used on pipelines pressurized to 50 psi.

The safe maximum operating pressure for this system is 50 psi.

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

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

General Features of the System

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

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

8. Is the system permanently installed on the pipeline?

(X) yes ( ) no

Does the system test the line automatically?

(X) yes ( ) no

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

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

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

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

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

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

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

( ) yes ( ) no

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

( ) operating pressure of line
( ) 150% of operating pressure
(X) a specific test pressure of 8-12 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?

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

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

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

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

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

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

( ) yes (X) no

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

    (X) yes ( ) no

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

    ( ) yes (X) no

20. Are deviations from this protocol acceptable?

    ( ) yes (X) no

    If yes, briefly specify: _____
    _____
    _____

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

    ( ) yes (X) no

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

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

Data Acquisition

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

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

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

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

Detection Criterion

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

    2 gal/hr @ 8-12 psi (in the units used by the measurement system)
    2 gal/hr @ 8-12 psi (in gal/h)

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

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

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

Calibration

26. How frequently are the sensor systems calibrated?

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

Attachment 2
Summary of Performance Estimates

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

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

Performance of the Pipeline Leak Detection System as Evaluated

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

Probability of False Alarm as a Function of Threshold

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

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

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

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

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

Attachment 3

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

Pipeline Leak Detection System
Options 1, 2, and 5

Specialized Test Facility, Operational Storage Tank System, or Computer Simulation	
Inside diameter of pipeline (in.)	3 in
Length of pipeline (tank to dispenser) (ft)	350 ft
Volume of product in line during testing (gal)	158
Type of material (fiberglass, steel, other[1])	FRP
Type of product in tank and pipeline (gasoline, diesel, other[2])	gasoline
Was a mechanical line leak detector present? (yes or no)	yes
Was trapped vapor present? (yes or no)	in 3 of 53 tests
Bulk Modulus (B) (psi)	33,639
B/V_o (psi/ml)	0.056
Storage tank capacity (gal)	560 gal

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

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.