



# **Evaluation of the Vaporless 99 LD-2000 Mechanical Line Leak Detector**

**(Addendum to the November 19, 1990  
Performance Evaluation of the Vaporless  
LD 2000 Line Leak Detector)**

## **Final Report**

**Prepared For:  
Vaporless Manufacturing, Inc.**

**November 10, 1998**



**Ken Wilcox Associates, Inc.**  
1125 Valley Ridge Drive, Grain Valley, MO 64029, USA  
Voice (816) 443-2494, Fax (816) 443-2495  
E-mail [info@kwaleak.com](mailto:info@kwaleak.com), Web <http://www.kwaleak.com>

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**Prepared For:  
Vaporless Manufacturing, Inc.  
8700 East Long Mesa Drive  
Prescott Valley, AZ 83614**

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## Preface

The data contained in this report was obtained from the Vaporless 99 LD-2000 Mechanical Line Leak Detector. This report is to be used in conjunction with the November 19, 1990 evaluation of the Vaporless system.<sup>1</sup> This report contains test data that was collected in October 1998 on rigid and flexible pipelines to verify that the 99 LD-2000 could detect a 3 gal/h leak in the same manner as the original version of the LD-2000. Testing was performed in accordance with the EPA Pipeline Leak Detection Test Protocol<sup>2</sup> with the exception of the number of tests performed. All testing was conducted at the Fuels Management Research Center (FMRC) operated by Ken Wilcox Associates, Inc.

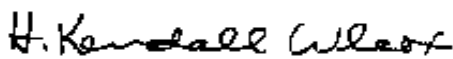
This report was prepared by Mr. Jeffrey K. Wilcox, Ken Wilcox Associates, Inc. Questions regarding this addendum should be directed to Mr. Greg Young, Vaporless Manufacturing, Inc. (800) 367-0185.

KEN WILCOX ASSOCIATES, INC.



Jeffrey K. Wilcox, Engineer

Approved:



H. Kendall Wilcox, Ph.D.  
President

November 10, 1998

<sup>1</sup> Performance Evaluation of the Vaporless LD 2000 Line Leak Detector, Final Report, For Vaporless Manufacturing, November 19, 1990, Ken Wilcox Associates, Inc.

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

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## 1.0 Introduction

This report contains the results of testing conducted on the 99 LD-2000. A limited number of tests were conducted which were designed to verify that the 99 LD-2000 could detect a 3 gal/h leak in the same manner as the original LD 2000 mechanical line leak detector. Testing was performed in accordance with the EPA Pipeline Leak Detection Test Protocol<sup>1</sup> with the exception of the number of tests performed <sup>2</sup>

This report is to be used in conjunction with the November 19, 1990 evaluation of the Vaporless LD 2000 mechanical line leak detector.<sup>3</sup> Several evaluations have been conducted on various LD 2000 models to determine performance parameters.<sup>4</sup> The original LD 2000 evaluation (November 19, 1990) was conducted on a rigid pipeline that was 176 ft. in length by 3 3/8 inches in diameter with a volume of 81.5 gallons. The results of the testing determined that the LD 2000 had an estimated probability of detection ( $P_D$ ) of 100% with an upper confidence interval of 92 to 100% and an estimated probability of false alarm ( $P_{FA}$ ) of 0% with a lower confidence limit of 0 to 8%.

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<sup>1</sup> “Standard Test Procedures for Evaluating Leak Detection Methods: Pressurized Pipeline Leak Detection Systems”, EPA/530/UST-90/010, September, 1990.

<sup>2</sup> The EPA protocol requires that 50 tests be conducted under various conditions for a full evaluation. This evaluation consisted of 6 tests on a rigid line and 6 tests on a flexible line.

<sup>3</sup> Performance Evaluation of the Vaporless LD 2000 Line Leak Detector, Final Report, For Vaporless Manufacturing, November 19, 1990, Ken Wilcox Associates, Inc.

<sup>4</sup> Three previous evaluations were conducted on versions of the LD-2000 for Hourly Testing. Evaluation reports written by KWA, Inc. for the following models of the LD-2000 are available from Vaporless Manufacturing: LD-2000 and LD-2000S, 11/19/90; LD-2000E and LD-2000E-S, 12/11/92; LD-2000T and LD-2000T-S, 7/13/93.

## 2.0 Background

The federal Environmental Protection Agency (EPA) has provided a series of documents<sup>5</sup> which describe the procedures which are to be used to verify that leak detection equipment meets the performance requirements of the Federal Register.<sup>6</sup> At the minimum, a leak detector which 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. Other options include the use of equipment which is capable of detecting 0.20 gal/hr on a monthly basis or an annual test capable of detecting leaks of 0.10 gal/hr. 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%.

To provide a mechanism for achieving compliance with the requirements for leak detection on pressurized piping, the EPA has developed a test protocol “Standard Test Procedures for Evaluating Leak Detection Methods: Pressurized Pipeline Leak Detection Systems”, EPA/530/UST-90/010, September, 1990. Testing conducted for this addendum were evaluated according to the EPA protocol with the exception of the number of tests conducted.

The EPA protocol does not require that systems be tested on both rigid and flexible pipelines. However, some federal, state, and local regulators have required additional testing on flexible pipelines for systems that were originally evaluated on rigid pipelines. This addendum includes the results of testing conducted on flexible piping in response to those regulator’s requirements.

<sup>5</sup> “Standard Test Procedures for Evaluating Leak Detection Methods,” EPA/530 UST90/001-7, March to October 1990. Seven different procedures were developed for different leak detection methods and released between March and October 1990.

<sup>6</sup> 40CFR Part 280, Subpart D.

### **3.0 Overview of the Evaluation Procedures and the Testing Conditions**

A total of 12 tests were conducted for this evaluation. Six tests were conducted on the 99 LD-2000 on each type of pipeline (rigid and flexible). The test conditions and results for these tests are provided in Tables 1 and 2. Of the six tests on each line, three leak tests and three tight tests were conducted.

Testing was conducted at rates equivalent to 3 gal/h at 10 psi for Hourly Testing. Testing was conducted at the temperature extremes of  $\pm 25$  deg F and at neutral. The  $\pm 25$  deg F temperature differences are the extremes required for EPA certification. If a leak detector is successful at these temperature differences, it would also be expected to pass at less extreme temperature differences.

**Table 1. Data and Results for Testing Conducted on Rigid Pipeline**

Test No.	Date Test Began	Time Circulation Started	Time Circulation Ended	Time Data Collection Began	Time Data Collection Ended	Duration of Circulation	Time Between End of Circulation and Start of Data Collection	Duration of Data Collection	T(TB) (Product Temp.)	T(G) (Ground Temp.)	T(TB)-T(G) (Temp. Differential)	Temp. Matrix Category	Induced Leak Rate	Measured Test Result
	mm/dd/yy	hhmm	hhmm	hhmm	hhmm	hhmm	hhmm	hhmm	deg F	deg F	deg F	deg F	gal/h	
1	10/14/1998	1045	1145	1145	1145	0100	0000	0000	66.74	65.60	1.14	+5 to -5	0	Tight
2	10/14/1998	1045	1145	1145	1146	0100	0000	0001	66.74	65.60	1.14	+5 to -5	3.0	Leak
3	10/15/1998	0925	1025	1025	1025	0100	0000	0000	37.40	63.43	-26.03	< -25	0	Tight
4	10/15/1998	0925	1025	1025	1026	0100	0000	0001	37.40	63.43	-26.03	< -25	3.0	Leak
5	10/15/1998	1340	1440	1440	1500	0100	0000	0020	88.34	63.54	24.80	> +25	0	Tight
6	10/15/1998	1340	1440	1500	1505	0100	0020	0005	88.34	63.54	24.80	> +25	3.0	Leak

**Table 1. Data and Results for Testing Conducted on Flexible Pipeline**

Test No.	Date Test Began	Time Circulation Started	Time Circulation Ended	Time Data Collection Began	Time Data Collection Ended	Duration of Circulation	Time Between End of Circulation and Start of Data Collection	Duration of Data Collection	T(TB) (Product Temp.)	T(G) (Ground Temp.)	T(TB)- T(G) (Temp. Differential)	Temp. Matrix Category	Induced Leak Rate	Measured Test Result
	mm/dd/yy	hhmm	hhmm	hhmm	hhmm	hhmm	hhmm	hhmm	deg F	deg F	deg F	deg F	gal/h	
7	10/14/98	1155	1255	1255	1255	0100	0000	0000	67.28	63.84	3.44	+5 to -5	0	Tight
8	10/14/98	1155	1255	1255	1256	0100	0000	0001	67.28	63.84	3.44	+5 to -5	3.0	Leak
9	10/14/98	1405	1505	1505	1505	0100	0000	0000	38.30	64.42	-26.12	< -25	0	Tight
10	10/14/98	1405	1505	1505	1506	0100	0000	0001	38.30	64.42	-26.12	< -25	3.0	Leak
11	10/15/98	1230	1330	1330	1330	0100	0000	0000	87.80	61.86	25.94	> +25	0	Tight
12	10/15/98	1230	1330	1330	1331	0100	0000	0001	87.80	61.86	25.94	> +25	3.0	Leak



#### **4.0 Description of the Testing Location**

The Vaporless system was evaluated at the Fuels Management Research Center which is located in Grain Valley, Missouri and operated by Ken Wilcox Associates, Inc. All line tests were conducted using regular unleaded gasoline. Testing for this addendum was conducted on a 200 ft. fiberglass pipeline with a volume of 85 gallons and a 215 ft. flexible pipeline with a total volume of 19.7 gallons. The bulk modulus was 34,443 psi for the rigid line and 4,485 psi for the flexible pipeline.

The 99 LD-2000 was installed by the manufacturer in its usual configuration in a standard Red Jacket pump. The Red Jacket pump was installed in a 600 gallon tank where product was thermally conditioned according to the EPA protocol requirements. Product was heated or cooled in the 600 gallon tank by circulating glycol and product through an external heat exchanger. Soil temperatures were monitored by temperature sensors located at 2 inches, 4 inches and 12 inches from the line as specified by the protocol. A single temperature sensor 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 between the soil and the product.

## 5.0 Description of the 99 LD-2000

The 99 LD-2000 mechanical leak detector incorporates a poppet valve and metering pin. When the pump is activated, fuel is metered into the line to raise the pressure. If the pressure rises above 24 psi, the poppet valve opens and full flow into the line occurs. If the pressure fails to rise above 24 psi, fuel flow in the line is restricted to approximately 2 gal/min.

The 99 LD-2000 mechanical line leak detector is based on the original LD-2000 developed by Vaporless in 1990. Features of the 99 LD-2000 include:

- Drastically reduced piston size of the leak detector making for a much more responsive leak detector, significantly reducing the fuel needed to pass through the metering pin and poppet to allow full flow of the pump.
- Eliminates traditional fuel flow path to the piston allowing the leak detector metering system better isolation from the turbulence and hydraulic effects found in the pump head during pump startup. This fuel flow change also eliminates the mechanical and thermal effects present in the upper half of the pump, allowing the leak detector to only respond to line pressure changes.
- More responsive leak detectors allowing the line to open up for pumping more quickly. When the pump is off, it will reset to leak sense position faster because of the smaller amount of fuel under the piston. Additionally, the leak detector does not have to completely reset to cycle through the leak sense position. If the line pressure falls as low as 5 psi (when the pump is off), the leak detector is forced into the leak sense mode.
- Reduced surface area of the piston results in less exposure to hydraulic line shock, enhancing leak detection performance not only in steel and fiberglass lines but also in flexible piping systems.
- Higher leak sense pressure is possible due to the reduced piston area. The leak detector stays in the fast fill position to a higher pressure, compressing vapor pockets or removing stretch from flexible pipe faster.
- Field adjustment access in cap to adjust sensitivity for wear or field variables such as deep burial or excessive trapped vapor.
- Integrated check valve to compensate for pump component failure such as leaking check valves in the turbine, defective submersible pump pressure reliefs, or defective bypass valves. If pump component failure occurs the integrated check valve does not allow the system to depressurize and reset the leak detector.

## 6.0 Test Results and Limitations

The performance parameters for the 99 LD-2000 are summarized in Table 3.

### Probability of Detection ( $P_D$ )

The 99 LD-2000 was correct in its determination of a leak for all of the leak tests. The estimated  $P_D$  of a 3 gal/h leak is 100% with an upper confidence limit of 61 to 100%.

### Probability of False Alarm ( $P_{FA}$ )

The 99 LD-2000 was correct in its determination of a tight pipeline for all of the tight tests. The estimated  $P_{FA}$  is 0% with a lower confidence limit of 0 to 39%.

### Time to Conduct a Test

All of the tests were completed in under one minute with one exception. One of the tests required 20 minutes to complete due to a temperature differential extreme that was present during the test (See Table 1).

### Maximum Line Size

The EPA protocol allows pipeline leak detection methods to be used on pipelines with up to twice the volume of that used in the evaluation. If the EPA protocol is used to calculate the performance parameters, the 99 LD-2000 can be used on rigid pipelines up to 170 gallons and flexible pipelines up to 39.5 gallons.

**Table 2. Summary of the Test Results and Limitations**

Parameter	Value
<b>Probability of Detection for a 3 gal/h leak</b> Confidence Limits	100% 69 to 100%
<b>Probability of False Alarm</b> Confidence Limits	0% 0 to 39%
<b>Time to Conduct a Test</b>	< 1 minute to 20 minutes depending on line conditions
<b>Maximum Applicable Rigid Line Size</b>	170 gallons
<b>Maximum Applicable Flexible Line Size</b>	39.5 gallons