# Evaluation of the Red Jacket Electronics Leak Detection Sensors

## EPA Results Forms

PREPARED FOR:

**Marley Pump Co.**
**a United Dominion Company**

**June 1, 1995**

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KEN WILCOX ASSOCIATES, INC. - 19401 E. 40 Highway
Independence ,MO 64055 - (816) 795-7997

# Evaluation of the Red Jacket Electronics Leak Detection Sensors

## EPA Results Forms

PREPARED FOR:

**Marley Pump Co.**
**a United Dominion Company**
**5800 Foxridge Drive**
**Mission, Kansas 66202**

**June 1, 1995**

## Preface

The data contained in this report was obtained from the Red Jacket Electronics Leak Detection Sensors. The test results are based on data collected using a modification of the EPA protocol "Liquid-Phase Out-of-Tank Product Detectors", EPA/530/UST-90/009. The work was conducted at the Leak Detection Test Center which is operated by Ken Wilcox Associates, Inc. Technical questions should be directed to Mr. Larry Seiter, Marley Pump Co., at (913) 541-2931.

KEN WILCOX ASSOCIATES, INC.

H. Kendall Wilcox

H. Kendall Wilcox, President
June 1, 1995

# Modified Procedure
# Results of U.S. EPA Standard Evaluation
# Liquid-Phase Product Detectors

This form documents the performance of the liquid-phase product detector described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluation Leak Detection Methods: Liquid-Phase Out-of-tank Liquid Product Detectors". The modifications to the procedure were made to accommodate the specialized requirements of interstitial monitors.

Tank owners using this leak detection system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

## Method Description

Name Red Jacket Electronics Combination High Level/Low Level Sensor

Version number RE400-179-5 to RE400-199-5 (Numbered by length of sensor)

Vendor Marley Pump Co. (A United Dominion Company)

5800 Foxridge Drive
(street address)

Mission, KS 66202 (913) 831-5700
(city) (state) (zip) (phone)

Detector output type: ( ) Quantitative (x) Qualitative

Detector operating principle: ( )Electrical Conductivity ( ) Thermal Conductivity ( ) Interface Probe ( ) Product Permeable ( ) Product Soluble (X) Other Float Switch

Detector sampling frequency: ( ) Intermittent (X) Continuous

## Evaluation Results

The detectors listed above were tested for their ability to detect liquid level changes (hydrocarbon or water) in a tank or a sump. The following parameters were determined:

Lower Detection Limit - The smallest product height that the detector can reliably detect.

Specificity - Whether or not the sensor responds to various products.

Precision - Agreement between multiple measurements of the same product level

Detection Time - Amount of time the detector must be exposed to product before it responds.

**Evaluation Results (continued)**

**> Compiled Test Results** (for tests conducted at the lower detection limit)

| Test | Gasoline | Water | Diesel |
|---|---|---|---|
| Probability of Detection | 100 | 100 | 100 |
| Probability of False Alarm | 0 | 0 | 0 |
| Accuracy (%) | 100 | 100 | 100 |
| Bias | N/A | N/A | N/A |
| Precision (%) | * | * | * |
| Detection Time (hh:mm:ss) | < 00:00:01 | < 00:00:01 | < 00:00:01 |
| Lower Detection Limit (in) | * | * | * |

*See Attached Table.

**Specificity Results (%)****

| | |
|---|---|
| Commercial gasoline | 100 |
| Synthetic gasoline | 100 |
| Diesel fuel | 100 |
| n-Hexane | 100 |
| Toluene | 100 |
| Xylene(s) | 100 |
| Water | 100 |

**The sensor will respond to any liquid once the threshold has been exceeded.

**> Safety disclaimer: This test procedure only addresses the issue of the interstitial monitors ability to detect leaks. It does not test the equipment for safety hazards.**

**Certification of Results**

I certify that the interstitial monitor was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed using the procedures described in the modified test protocol.

H. Kendall Wilcox, President
(printed name)

H. Kendall Wilcox
(Signature)

June 1, 1995
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Independence, MO 64055
(city, state, zip)

(816) 795-7997
(phone number)

**Test Results for the Red Jacket Electronics Combination High Level/Low Level Sensor**
**Model Numbers: RE400-179-5 to RE400-199-5 (Numbered by Length of Sensor)**

**Low Level**

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | 1.375 | 1.474 | 1.658 |
| 2 | 1.375 | 1.482 | 1.658 |
| 3 | 1.380 | 1.474 | 1.665 |
| 4 | 1.375 | 1.482 | 1.658 |
| 5 | 1.383 | 1.474 | 1.658 |
| 6 | 1.375 | 1.474 | 1.665 |
| **Mean (in)** | 1.377 | 1.477 | 1.660 |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | 1.393 | 1.495 | 1.676 |
| **Precision (Std Dev)** | 0.003488 | 0.004131 | 0.003615 |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |

**High Level**

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | * | * | * |
| 2 | * | * | * |
| 3 | * | * | * |
| 4 | * | * | * |
| 5 | * | * | * |
| 6 | * | * | * |
| **Mean (in)** | N/A | N/A | N/A |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | N/A | N/A | N/A |
| **Precision (Std Dev)** | N/A | N/A | N/A |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |

* Determined by the length of the sensor, which varies depending upon the model.

# Modified Procedure
# Results of U.S. EPA Standard Evaluation
# Liquid-Phase Product Detectors

This form documents the performance of the liquid-phase product detector described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluation Leak Detection Methods: Liquid-Phase Out-of-tank Liquid Product Detectors". The modifications to the procedure were made to accommodate the specialized requirements of interstitial monitors.

Tank owners using this leak detection system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

## Method Description

Name Red Jacket Electronics Hydrostatic Sensor

Version number RE400-042-5

Vendor Marley Pump Co. (A United Dominion Company)

5800 Foxridge Drive
(street address)

Mission, KS 66202 (913) 831-5700
(city) (state) (zip) (phone)

Detector output type: ( ) Quantitative (x) Qualitative

Detector operating principle: ( )Electrical Conductivity ( ) Thermal Conductivity ( ) Interface Probe ( ) Product Permeable ( ) Product Soluble (X) Other Float Switch

Detector sampling frequency: ( ) Intermittent (X) Continuous

## Evaluation Results

The detectors listed above were tested for their ability to detect a liquid level changes (hydrocarbon or water) in a tank or a sump. The following parameters were determined:

Lower Detection Limit - The smallest product height that the detector can reliably detect.

Specificity - Whether or not the sensor responds to various products.

Precision - Agreement between multiple measurements of the same product level

Detection Time - Amount of time the detector must be exposed to product before it responds.

**Evaluation Results (continued)**

**> Compiled Test Results** (for tests conducted at the lower detection limit)

| Test | Gasoline | Water | Diesel |
|---|---|---|---|
| Probability of Detection | 100 | 100 | 100 |
| Probability of False Alarm | 0 | 0 | 0 |
| Accuracy (%) | 100 | 100 | 100 |
| Bias | N/A | N/A | N/A |
| Precision (%) | * | * | * |
| Detection Time (hh:mm:ss) | < 00:00:01 | < 00:00:01 | < 00:00:01 |
| Lower Detection Limit (in) | * | * | * |

*See Attached Table.

**Specificity Results (%)****

| | |
|---|---|
| Commercial gasoline | 100 |
| Synthetic gasoline | 100 |
| Diesel fuel | 100 |
| Jet-A jet fuel | 100 |
| n-Hexane | 100 |
| Toluene | 100 |
| Xylene(s) | 100 |
| Water | 100 |

**The sensor will respond to any liquid once the threshold has been exceeded.

**> Safety disclaimer: This test procedure only addresses the issue of the interstitial monitors ability to detect leaks. It does not test the equipment for safety hazards.**

**Certification of Results**

I certify that the interstitial monitor was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed using the procedures described in the modified test protocol.

H. Kendall Wilcox, President
(printed name)

H. Kendall Wilcox
(Signature)

June 1, 1995
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Independence, MO 64055
(city, state, zip)

(816) 795-7997
(phone number)

**Test Results for the Red Jacket Electronics Hydrostatic Sensor**
**Model Number: RE400-042-5**

**Low Level**

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | 1.624 | 1.920 | 1.798 |
| 2 | 1.618 | 1.914 | 1.792 |
| 3 | 1.630 | 1.920 | 1.786 |
| 4 | 1.630 | 1.926 | 1.798 |
| 5 | 1.624 | 1.920 | 1.798 |
| 6 | 1.630 | 1.926 | 1.792 |
| **Mean (in)** | 1.626 | 1.921 | 1.794 |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | 1.648 | 1.941 | 1.816 |
| **Precision (Std Dev)** | 0.004899 | 0.004517 | 0.004899 |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |

**High Level**

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | 11.745 | 11.964 | 11.875 |
| 2 | 11.753 | 11.956 | 11.867 |
| 3 | 11.761 | 11.956 | 11.875 |
| 4 | 11.761 | 11.964 | 11.858 |
| 5 | 11.753 | 11.956 | 11.867 |
| 6 | 11.761 | 11.956 | 11.867 |
| **Mean (in)** | 11.756 | 11.959 | 11.868 |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | 11.784 | 11.977 | 11.896 |
| **Precision (Std Dev)** | 0.006532 | 0.004131 | 0.006338 |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |

# Modified Procedure
# Results of U.S. EPA Standard Evaluation
# Liquid-Phase Product Detectors

This form documents the performance of the liquid-phase product detector described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluation Leak Detection Methods: Liquid-Phase Out-of-tank Liquid Product Detectors". The modifications to the procedure were made to accommodate the specialized requirements of interstitial monitors.

Tank owners using this leak detection system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

## Method Description

Name Red Jacket Electronics Overfill Sensor

Version number RE400-058-5, RE400-059-5, RE400-147-5, RE400-148-5

(Numbered by float logic and well cap size)

Vendor Marley Pump Co. (A United Dominion Company)

5800 Foxridge Drive
(street address)

Mission, KS 66202 (913) 831-5700
(city) (state) (zip) (phone)

Detector output type: ( ) Quantitative (x) Qualitative

Detector operating principle: ( )Electrical Conductivity ( ) Thermal Conductivity ( ) Interface Probe ( ) Product Permeable ( ) Product Soluble (X) Other Float Switch

Detector sampling frequency: ( ) Intermittent (X) Continuous

## Evaluation Results

The detectors listed above were tested for their ability to detect liquid level changes (hydrocarbon or water) in a tank or a sump. The following parameters were determined:

Lower Detection Limit - The smallest product height that the detector can reliably detect.

Specificity - Whether or not the sensor responds to various products.

Precision - Agreement between multiple measurements of the same product level

Detection Time - Amount of time the detector must be exposed to product before it responds.

**Evaluation Results (continued)**

**> Compiled Test Results** (for tests conducted at the lower detection limit)

| Test | Gasoline | Water | Diesel |
|---|---|---|---|
| Probability of Detection | 100 | 100 | 100 |
| Probability of False Alarm | 0 | 0 | 0 |
| Accuracy (%) | 100 | 100 | 100 |
| Bias | N/A | N/A | N/A |
| Precision (%) | * | * | * |
| Detection Time (hh:mm:ss) | < 00:00:01 | < 00:00:01 | < 00:00:01 |
| Lower Detection Limit (in) | * | * | * |

*See Attached Table.

**Specificity Results (%)****

| | |
|---|---|
| Commercial gasoline | 100 |
| Synthetic gasoline | 100 |
| Diesel fuel | 100 |
| Jet-A jet fuel | 100 |
| n-Hexane | 100 |
| Toluene | 100 |
| Xylene(s) | 100 |
| Water | 100 |

**The sensor will respond to any liquid once the threshold has been exceeded.

**> Safety disclaimer: This test procedure only addresses the issue of the interstitial monitors ability to detect leaks. It does not test the equipment for safety hazards.**

**Certification of Results**

I certify that the interstitial monitor was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed using the procedures described in the modified test protocol.

H. Kendall Wilcox, President
(printed name)

H. Kendall Wilcox
(Signature)

June 1, 1995
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Independence, MO 64055
(city, state, zip)

(816) 795-7997
(phone number)

**Test Results for the Red Jacket Overfill Sensor**
**Model Numbers: RE400-058-5, RE400-059-5, RE-147-5, RE400-148-5**
**(Numbered by Well Cap Size or Float Logic)**

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | 1.000 | 1.160 | 1.100 |
| 2 | 1.005 | 1.150 | 1.095 |
| 3 | 1.005 | 1.155 | 1.095 |
| 4 | 1.000 | 1.150 | 1.100 |
| 5 | 1.000 | 1.150 | 1.100 |
| 6 | 1.000 | 1.150 | 1.100 |
| **Mean (in)** | 1.002 | 1.153 | 1.098 |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | 1.013 | 1.171 | 1.110 |
| **Precision (Std Dev)** | 0.002582 | 0.004183 | 0.002582 |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |

# Modified Procedure
# Results of U.S. EPA Standard Evaluation
# Liquid-Phase Product Detectors

This form documents the performance of the liquid-phase product detector described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluation Leak Detection Methods: Liquid-Phase Out-of-tank Liquid Product Detectors". The modifications to the procedure were made to accommodate the specialized requirements of interstitial monitors.

Tank owners using this leak detection system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

## Method Description

Name Red Jacket Electronics Sump Sensor

Version number RE400-111-5

Vendor Marley Pump Co. (A United Dominion Company)

5800 Foxridge Drive
(street address)

Mission, KS 66202 (913) 831-5700
(city) (state) (zip) (phone)

Detector output type: ( ) Quantitative (x) Qualitative

Detector operating principle: ( )Electrical Conductivity ( ) Thermal Conductivity ( ) Interface Probe ( ) Product Permeable ( ) Product Soluble (X) Other Float Switch

Detector sampling frequency: ( ) Intermittent (X) Continuous

## Evaluation Results

The detectors listed above were tested for their ability to detect liquid level changes (hydrocarbon or water) in a tank or a sump. The following parameters were determined:

Lower Detection Limit - The smallest product height that the detector can reliably detect.

Specificity - Whether or not the sensor responds to various products.

Precision - Agreement between multiple measurements of the same product level

Detection Time - Amount of time the detector must be exposed to product before it responds.

**Evaluation Results (continued)**

**> Compiled Test Results** (for tests conducted at the lower detection limit)

| Test | Gasoline | Water | Diesel |
|---|---|---|---|
| Probability of Detection | 100 | 100 | 100 |
| Probability of False Alarm | 0 | 0 | 0 |
| Accuracy (%) | 100 | 100 | 100 |
| Bias | N/A | N/A | N/A |
| Precision (%) | * | * | * |
| Detection Time (hh:mm:ss) | < 00:00:01 | < 00:00:01 | < 00:00:01 |
| Lower Detection Limit (in) | * | * | * |

*See Attached Table.

**Specificity Results (%)****

| | |
|---|---|
| Commercial gasoline | 100 |
| Synthetic gasoline | 100 |
| Diesel fuel | 100 |
| Jet-A jet fuel | 100 |
| n-Hexane | 100 |
| Toluene | 100 |
| Xylene(s) | 100 |
| Water | 100 |

**The sensor will respond to any liquid once the threshold has been exceeded.

**> Safety disclaimer: This test procedure only addresses the issue of the interstitial monitors ability to detect leaks. It does not test the equipment for safety hazards.**

**Certification of Results**

I certify that the interstitial monitor was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed using the procedures described in the modified test protocol.

H. Kendall Wilcox, President
(printed name)

H. Kendall Wilcox
(Signature)

June 1, 1995
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Independence, MO 64055
(city, state, zip)

(816) 795-7997
(phone number)

**Test Results for the Red Jacket Electronics Sump Sensor**
**Model Number: RE400-111-5**

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | 1.248 | 1.406 | 1.325 |
| 2 | 1.248 | 1.402 | 1.330 |
| 3 | 1.243 | 1.397 | 1.320 |
| 4 | 1.243 | 1.402 | 1.325 |
| 5 | 1.248 | 1.402 | 1.325 |
| 6 | 1.243 | 1.397 | 1.320 |
| **Mean (in)** | 1.246 | 1.401 | 1.324 |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | 1.258 | 1.416 | 1.341 |
| **Precision (Std Dev)** | 0.002739 | 0.003464 | 0.003764 |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |

# Modified Procedure
# Results of U.S. EPA Standard Evaluation
# Liquid-Phase Product Detectors

This form documents the performance of the liquid-phase product detector described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to the U.S. EPA's "Standard Test Procedure for Evaluation Leak Detection Methods: Liquid-Phase Out-of-tank Liquid Product Detectors". The modifications to the procedure were made to accommodate the specialized requirements of interstitial monitors.

Tank owners using this leak detection system should keep this form on file to prove compliance with the federal regulations. Tank owners should check with State and local agencies to make sure this form satisfies their requirements.

## Method Description

Name Red Jacket Electronics Optical Liquid Discrimination Sensor

Version number RE400-203-5

Vendor Marley Pump Co. (A United Dominion Company)

5800 Foxridge Drive
(street address)

Mission, KS 66202 (913) 831-5700
(city) (state) (zip) (phone)

Detector output type: ( ) Quantitative (x) Qualitative

Detector operating principle: (X)Electrical Conductivity ( ) Thermal Conductivity ( ) Interface Probe ( ) Product Permeable ( ) Product Soluble (X) Other Optical

Detector sampling frequency: ( ) Intermittent (X) Continuous

## Evaluation Results

The detectors listed above were tested for their ability to detect and distinguish between hydrocarbon and water in a tank or a sump. The following parameters were determined:

Lower Detection Limit - The smallest product height that the detector can reliably detect.

Specificity - Whether or not the sensor responds to various products.

Precision - Agreement between multiple measurements of the same product level

Detection Time - Amount of time the detector must be exposed to product before it responds.

**Evaluation Results (continued)**

**> Compiled Test Results** (for tests conducted at the lower detection limit)

| Test | Gasoline | Water | Diesel |
|---|---|---|---|
| Probability of Detection | 100 | 100 | 100 |
| Probability of False Alarm | 0 | 0 | 0 |
| Accuracy (%) | 100 | 100 | 100 |
| Bias | N/A | N/A | N/A |
| Precision (%) | * | * | * |
| Detection Time (hh:mm:ss) | < 00:00:01 | < 00:00:01 | < 00:00:01 |
| Lower Detection Limit (in) | * | * | * |

*See Attached Table.

**Specificity Results (%)****

| | |
|---|---|
| Commercial gasoline | 100 |
| Synthetic gasoline | 100 |
| Diesel fuel | 100 |
| Jet-A jet fuel | 100 |
| n-Hexane | 100 |
| Toluene | 100 |
| Xylene(s) | 100 |
| Water | 100 |

**The sensor will respond to any liquid once the threshold has been exceeded.

**> Safety disclaimer: This test procedure only addresses the issue of the interstitial monitors ability to detect leaks. It does not test the equipment for safety hazards.**

**Certification of Results**

I certify that the interstitial monitor was installed and operated according to the vendor's instructions and that the results presented on this form are those obtained during the evaluation. I also certify that the evaluation was performed using the procedures described in the modified test protocol.

H. Kendall Wilcox, President
(printed name)

H. Kendall Wilcox
(Signature)

June 1, 1995
(date)

Ken Wilcox Associates, Inc.
(organization performing evaluation)

Independence, MO 64055
(city, state, zip)

(816) 795-7997
(phone number)

## Test Results for the Red Jacket Optical Liquid Dicrimination Sensor
## Model Number: RE400-203-5

| Run No. | Product | | |
|---|---|---|---|
| | Water | Unleaded Gasoline | Diesel |
| | Height to Alarm (in) | Height to Alarm (in) | Height to Alarm (in) |
| 1 | 0.422 | 0.442 | 0.432 |
| 2 | 0.422 | 0.437 | 0.427 |
| 3 | 0.418 | 0.437 | 0.432 |
| 4 | 0.422 | 0.442 | 0.427 |
| 5 | 0.418 | 0.446 | 0.432 |
| 6 | 0.413 | 0.446 | 0.432 |
| **Mean (in)** | 0.419 | 0.442 | 0.430 |
| **Accuracy** | 100 | 100 | 100 |
| **Threshold (in)** | 0.435 | 0.459 | 0.442 |
| **Precision (Std Dev)** | 0.003601 | 0.004033 | 0.002582 |
| **Detection Time** | < 1 second | < 1 second | < 1 second |
| **Fall Time** | < 1 second | < 1 second | < 1 second |