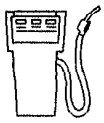

EVALUATION OF THE RED JACKET RLM 5000, RLM 5001, AND RLM 9000 AUTOMATIC TANK GAUGING SYSTEMS FOR MONTHLY MONITORING AND ANNUAL TIGHTNESS TESTING

FINAL REPORT

PREPARED FOR

RED JACKET ELECTRONICS

SEPTEMBER 16, 1991

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KEN WILCOX ASSOCIATES, 1312 S 21ST ST, BLUE SPRINGS, MO 64015

EVALUATION OF THE RED JACKET RLM 5000, RLM 5001, AND RLM 9000 AUTOMATIC TANK GAUGING SYSTEMS FOR MONTHLY MONITORING AND ANNUAL TIGHTNESS TESTING

FINAL REPORT

PREPARED FOR
RED JACKET ELECTRONICS
5800 FOXRIDGE DRIVE
MISSION, KANSAS 66202

SEPTEMBER 16, 1991

Preface

The forms contained in this report are based on data collected using the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: "Automatic Tank Gauging Systems", EPA/530/UST-90/006, March, 1990. The work was conducted at the Leak Detection Test Center which is operated by Ken Wilcox Associates. Questions should be directed to Mr. Klaus Jarr, Red Jacket Electronics, at (913) 831-5700.

H. Kendall Wilcox, PhD
KEN WILCOX ASSOCIATES

H. Kendall Wilcox

September 16, 1991

Results of U.S. EPA Standard Evaluation
Automatic Tank Gauging System (ATGS)

This form tells whether the automatic tank gauging system (ATGS) described below complies with the performance requirements of the federal underground storage tank regulation. 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 Evaluating Leak Detection Methods: Automatic Tank Gauging Systems." The full evaluation report also includes a form describing the method and a form summarizing the test data.

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

ATGS Description

Name Red Jacket Automatic Tank Gauging System

Version number RLM 9000, RLM 5000, and RLM 5001

Vendor Red Jacket Electronics

5800 Foxridge Drive

Mission, Kansas 66202 (913) 831-5700

Evaluation Results

This ATGS, which declares a tank to be leaking when the measured leak rate exceeds the threshold of 0.058 gallon per hour, has a probability of false alarm [P(FA)] of 0.5 %.

The corresponding probability of detection [P(D)] of a 0.20 gallon per hour leak is >99.9 %.

The minimum water level (threshold) in the tank that the ATGS can detect is 1.04 inches.

The minimum change in water level that can be detected by the ATGS is 0.011 inches (provided that the water level is above the threshold).

Therefore, this ATGS (X) does ( ) does not meet the **federal** performance standards established by the U.S. Environmental Protection Agency (0.20 gallon per hour at P(D) of 95% and P(FA) of 5%), and this ATGS (X) does ( ) does not meet the **federal** performance standard of measuring water in the bottom of the tank to the nearest 1/8 inch.

Test Conditions During Evaluation

The evaluation testing was conducted in a 10,000 gallon (X) steel ( ) fiberglass tank that was 96 inches in diameter and 324 inches long.

The temperature difference between product added to fill the tank and product already in the tank ranged from -6.2 deg F to +7.6 deg F, with a standard deviation of 5.4 deg F.

The tests were conducted with the tank product levels 50 to 90 % full.
The product used in the evaluation was unleaded gasoline.

Name of ATGS Red Jacket Automatic Tank Gauging System
Version RLM 9000, RLM 5000, and RLM 5001

Limitations on the Results

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for installing and operating the ATGS are followed.
- The tank contains a product identified on the method description form.
- The tank is no larger than 15,000 gallons.
- The tank is at least 50 percent full.
- The waiting time after adding any substantial amount of product to the tank is 6 hours.
- The temperature of the added product does not differ more than 8.0 degrees Fahrenheit from that already in the tank.
- The total data collection time for the test is at least 3 hours.
- Other limitations specified by the vendor or determined during testing:

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

Certification of Results

I certify that the ATGS 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 according to one of the following:

(X) standard EPA test procedure for ATGS
( ) alternative EPA test procedure for ATGS

H. Kendall Wilcox, Ph.D.	Ken Wilcox Associates
(printed name)	(organization performing evaluation)
H. Kendall Wilcox	Blue Springs, MO 64015
(signature)	(city, state, zip)
June 11, 1991	(816) 229-0860
(date)	(phone number)

Description
Automatic Tank Gauging System

This section describes briefly the important aspects of the automatic tank gauging system (ATGS). It is not intended to provide a thorough description of the principles behind the system or how the equipment works.

ATGS Name and Version

Red Jacket Automatic Tank Gauging Systems - RLM 5000, RLM 5001, and RLM 9000

Product

> Product type

For what products can this ATGS be used? (check all applicable)

(X) gasoline

(X) diesel

(X) aviation fuel

(X) fuel oil #4

(X) fuel oil #6

(X) solvents

(X) waste oil

(X) other (list) Solvents compatible with sensors and with known coefficients of expansion and densities. Contact manufacturer for specific applications.

> Product level

What product level is required to conduct a test?

( ) greater than 90% full

(X) greater than 50% full

( ) other (specify) _____

Does the ATGS measure inflow of water as well as loss of product (gallon per hour)?

(X) yes

( ) no

Does the ATGS detect the presence of water in the bottom of the tank?

(X) yes

( ) no

Level Measurement

What technique is used to measure changes in product volume?

( ) directly measure the volume of product change

( ) changes in head pressure

( ) changes in buoyancy of a probe

( ) mechanical level measure (e.g., ruler, dipstick)

( ) changes in capacitance

( ) ultrasonic

(X) change in level of float (specify principle, e.g., capacitance, magnetostrictive, load cell, etc.) magnetostrictive

( ) other (describe briefly) _____

Temperature Measurement

If product temperature is measured during a test, how many temperature sensors are used?

( ) single sensor, without circulation

( ) single sensor, with circulation

( ) 2-4 sensors

(X) 5 or more sensors

( ) temperature-averaging probe

If product temperature is measured during a test, what type of temperature sensor is used?

(X) resistance temperature detector (RTD)

( ) bimetallic strip

( ) quartz crystal

( ) thermistor

( ) other (describe briefly) _____

If product temperature is not measured during a test, why not?

( ) the factor measured for change in level/volume is independent of temperature (e.g., mass)

( ) the factor measured for change in level/volume self-compensates for changes in temperature

( ) other (explain briefly) _____

Data Acquisition

How are the test data acquired and recorded?

( ) manually

( ) by strip chart

(X) by computer

Procedure information

> Waiting times

What is the minimum waiting period between adding a large volume of product (i.e., a delivery) and the beginning of a test (e.g., filling from 50% to 90-95% capacity)?

( ) no waiting period

( ) less than 3 hours

(X) 3-6 hours

( ) 7-12 hours

( ) more than 12 hours

( ) variable, depending on tank size, amount added, operator discretion, etc.

> Test duration

What is the minimum time for collecting data?

( ) less than 1 hour

( ) 1 hour

( ) 2 hours

( ) 3 hours

( ) 4 hours

( ) 5-10 hours

( ) more than 10 hours

(X) variable (explain) tests until standard deviation is acceptable

> Total time

What is the total time needed to test with this ATGS after a delivery?
(waiting time plus testing time)

__9__ hours _____ minutes (minimum)

__14__ hours _____ minutes (maximum)

What is the sampling frequency for the level and temperature measurements?

(X) more than once per second

( ) at least once per minute

( ) every 1-15 minutes

( ) every 16-30 minutes

( ) every 31-60 minutes

( ) less than once per hour

( ) variable (explain) _____

> Identifying and correcting for interfering factors

How does the ATGS determine the presence and level of the ground water above the bottom of the tank?

(X) observation well near tank

( ) information from USGS, etc.

(X) information from personnel on-site

(X) presence of water in the tank

( ) other (describe briefly) _____

( ) level of ground water above bottom of the tank not determined

How does the ATGS correct for the interference due to the presence of ground water above the bottom of the tank?

(X) system tests for water incursion

( ) different product levels tested and leak rates compared

( ) other (describe briefly) _____

( ) no action

How does the ATGS determine when tank deformation has stopped following delivery of product?

(X) wait a specified period of time before beginning test

( ) watch the data trends and begin test when decrease in product level has stopped

( ) other (describe briefly) _____

( ) no procedure

Are the temperature and level sensors calibrated before each test?

( ) yes

(X) no

If not, how frequently are the sensors calibrated?

( ) weekly

( ) monthly

( ) yearly or less frequently

(X) never

> Interpreting test results

How are level changes converted to volume changes (i.e., how is height-to-volume conversion factor determined)?

(X) actual level changes observed when known volume is added or removed (e.g., liquid metal bar)

(X) theoretical ratio calculated from tank geometry

(X) interpolation from tank manufacturer's chart

( ) other (describe briefly)

( ) not applicable; volume measured directly

How is the coefficient of thermal expansion (Ce) of the product determined?

( ) actual sample taken for each test and Ce determined from specific gravity

(X) value supplied by vendor of product

(X) average value for type of product

( ) other (describe briefly) _____

How is the leak rate (gallon per hour) calculated?

( ) average of subsets of all data collected

( ) difference between first and last data collected

( ) from data from last _____ hours of test period

(X) from data determined to be valid by statistical analysis

( ) other (describe) _____

What threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

( ) 0.05 gallon per hour

( ) 0.10 gallon per hour

( ) 0.20 gallon per hour

(X) other (list) 0.058

Under what conditions are test results considered inconclusive?

(X) too much variability in the data (standard deviation beyond a given value)

( ) unexplained product volume increase

( ) other (describe briefly) _____

Exceptions

Are there any conditions under which a test should not be conducted?

( ) water in the excavation zone

(X) large difference between ground temperature and delivered product temperature

( ) extremely high or low ambient temperature

( ) invalid for some products (specify) _____

( ) other (describe briefly) _____

What are acceptable deviations from the standard testing protocol?

(X) none

( ) lengthen the duration of test

( ) other (describe briefly) _____

What elements of the test procedure are determined by personnel on-site?

(X) product level when test is conducted

(X) when to conduct test

( ) waiting period between filling tank and beginning test

( ) length of test

( ) determination that tank deformation has subsided

( ) determination of "outlier" data that may be discarded

( ) other (describe briefly) _____

( ) none

Results of U.S. EPA Standard Evaluation
Volumetric Tank Tightness Testing Method

This form tells whether the tank tightness testing method described below complies with the performance requirements of the federal underground storage tank regulation. 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 Evaluating Leak Detection Methods: Volumetric Tank Tightness Testing Methods." The full evaluation report also includes a form describing the method and a form summarizing the test data.

Tank owners using this leak detection system should keep this form on file to provide 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 Automatic Tank Gauging System - Leak Detection Mode

Version number RLM 5000, RLM 5001, and RLM 9000

Vendor Red Jacket Electronics

5800 Foxridge Drive

Mission, Kansas 66202 (913) 831-5700

Evaluation Results

This method which declares a tank to be leaking when the measured leak rate exceeds the threshold of 0.058 gallon per hour, has a probability of false alarms [P(FA)] of 0.5 %.

The corresponding probability of detection [P(D)] of a 0.10 gallon per hour leak is 99.5 %.

Therefore, this method (X) does ( ) does not meet the **federal** performance standards established by the U.S. Environmental Protection Agency (0.10 gallon per hour at P(D) of 95% and P(FA) of 5%).

Test Conditions During Evaluation

The evaluation testing was conducted in a 10,000 gallon (X) steel ( ) fiberglass tank that was 96 inches in diameter and 324 inches long.

The tests were conducted with the tank product levels 50 to 90 percent full.

The temperature difference between product added to fill the tank and product already in the tank ranged from +7.6 deg F to -6.2 deg F, with a standard deviation of 5.4 deg F.

The product used in the evaluation was unleaded gasoline.

Limitations on the Results

The performance estimates above are only valid when:

- The method has not been substantially changed.
- The vendor's instructions for using the method are followed.
- The tank is no larger than 15,000 gallons.
- The tank contains a product identified on the method description form.
- The tank is at least 50 percent full.
- The waiting time after adding any substantial amount of product to the tank is at least 6 hours.
- The temperature of the added product does not differ more than 8.0 degrees Fahrenheit from that already in the tank.
- The waiting time between the end of "topping off," if any, and the start of the test data collection is at least N/A hours.
- The total data collection time for the test is at least varies hours.
- Large vapor pockets are identified and removed (for methods that overfill the tank).
- The method (X) can ( ) cannot be used if the ground-water level is above the bottom of the tank.
- Other limitations specified by the vendor or determined during testing:

  The water level in the tank is monitored continuously. Leaks which result in water ingress are detected by the water level monitor.

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

Certification of Results

I certify that the volumetric tank tightness testing method was operated according to the vendor's instructions. I also certify that the evaluation was performed according to the standard EPA test procedures for volumetric tank tightness testing methods and that the results presented above are those obtained during the evaluation.

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(printed name)	(organization performing evaluation)
H. Kendall Wilcox	Blue Springs, MO 64015
(signature)	(city, state. zip)
June 11, 1991	(816) 229-0860
(date)	(phone number)

Description

Volumetric Tank Tightness Testing Method

This section describes briefly the important aspects of the volumetric tank tightness testing method. It is not intended to provide a thorough description of the principles behind the method or how the equipment works.

Method Name and Version

Red Jacket Automatic Tank Gauging System - Leak Detection Mode
RLM 5000, RLM 5001, and RLM 9000

Product

> Product type

For what products can this method be used? (Check all applicable)

(X) gasoline

(X) diesel

(X) aviation fuel

( ) fuel oil #4

( ) fuel oil #6

(X) solvent

( ) waste oil

(X) other (list) methanol, ethanol, and their blends with gasoline

> Product Level

What minimum product level is required to conduct a test?

( ) above grade

( ) within the fill pipe

( ) greater than 90% full

( ) greater than 50% full

(X) other (specify) can test over the full range from empty to full

Is a method used to add or withdraw product to maintain a constant level of product?

( ) yes

(X) no (level remains approx. constant for an underfill method)

Does the method measure inflow of water as well as loss of product (gallon per hour)?

(X) yes

( ) no

Does the method detect the presence of water in the bottom of the tank?

(X) yes

( ) no

Level Measurement

What technique is used to measure changes in product volume?

( ) directly measure the volume of product change

( ) changes in head pressure

( ) changes in buoyancy of a probe

( ) mechanical level measure (e.g., ruler, dipstick)

( ) changes in capacitance

( ) ultrasonic

(X) change in level of float (specify principle, e.g., capacitance, magnetostrictive load cell, etc.) magnetostrictive

( ) other (describe briefly) _____

Temperature Measurement

If product temperature is measured during a test, how many temperature sensors are used?

( ) single sensor, without circulation

( ) single sensor, with circulation

( ) 2-4 sensors

(X) 5 or more sensors

( ) temperature averaging probe

If product temperature is measured during a test, what type of temperature sensor is used?

(X) resistance temperature detector (RTD)

( ) bimetallic strip

( ) quartz crystal

( ) thermistor

( ) other (describe briefly) _____

If product temperature is not measured during a test, why not?

( ) the factor measured for change in level/volume is independent of temperature (e.g., mass)

( ) the factor measured for change in level/volume self-compensates for changes in temperature

( ) other (explain briefly) _____

Data Acquisition

How are the test data acquired and recorded?

( ) manually

( ) by strip chart

(X) by computer

Procedure Information

> Waiting Times

What is the minimum waiting period between adding a large volume of product to bring the level to test requirements and the beginning of the test (e.g., from 50% to 95% capacity)?

( ) no waiting period

( ) less than 3 hours

(X) 3-6 hours

( ) 7-12 hours

( ) more than 12 hours

( ) variable, depending on tank size, amount added, operator discretion, etc.

What is the minimum waiting period between "topping off" the tank (adding a small amount of product to fine tune the desired level for testing, e.g., from 2 inches to 5 inches above grade) and beginning the test?

( ) no waiting period

( ) less than 1 hour

(X) 1-2 hours

( ) more than 2 hours

( ) variable, depending on the amount of product added

> Test duration

What is the minimum time for collecting data?

( ) less than 1 hour

( ) 1 hour

( ) 2 hours

( ) 3 hours

( ) 4 hours

( ) 5-10 hours

( ) more than 10 hours

(X) variable (until statistically significant data is obtained, ususally 3 to 6 hrs depending on product level)

> Total time

What is the total time needed to test with this method?
(setup time plus waiting time plus testing time plus time to return tank to service)
9 to 14 hours ___ minutes (Probe is permanently installed. Test time is from 3 to 8 hrs + 6 hrs after delivery.)

What is the sampling frequency for the level and temperature measurements

(X) more than once per second

( ) at least once per minute

( ) every 1-15 minutes

( ) every 16-30 minutes

( ) every 31-60 minutes

( ) less than once per hour

( ) variable

> Identifying and correcting for interfering factors

How does the method determine the presence and level of the ground water above the bottom of the tank?

( ) observation well near tank

( ) information from USGS, etc.

( ) information from personnel on-site

( ) presence of water in the tank

( ) other (describe briefly) _____

(X) level of ground water above bottom of the tank not determined

How does the method correct for the interference due to the presence of ground water above the bottom of the tank?

( ) head pressure increased by raising the level of the product

( ) different head pressures tested and leak rates compared

( ) method tests for changes in water level in tank

(X) other (describe briefly) Testing can be conducted at multiple product levels.

( ) no action

How does the method identify the presence of vapor pockets?

( ) erratic temperature, level, or temperature-compensated volume readings

( ) sudden large changes in readings

( ) statistical analysis of variability of readings

( ) other (describe briefly) _____

( ) not identified

(X) not applicable; underfilled test method used

How does the method correct for the presence of vapor pockets?

( ) bleed off vapor and start test over

( ) identify periods of pocket movement and discount data from analysis

( ) other (describe briefly) _____

( ) not corrected

(X) not applicable; underfilled test method used

How does the test method determine when tank deformation has stopped following delivery of product?

( ) wait a specified period of time before beginning test

( ) watch the data trends and begin test when decrease in product level has stopped

(X) other (describe briefly) Testing should not be conducted until approx. 6hr after a drop

( ) no procedure

Are the temperature and level sensors calibrated before each use?

( ) yes

(X) no

If not, how often are the sensors calibrated?

( ) weekly

( ) monthly

( ) yearly or less frequently

(X) never

> Interpreting test results

How are level changes converted to volume changes (i.e., how is height-to-volume conversion factor determined)?

( ) actual level changes observed when know volume is added or removed (e.g., liquid, metal bar)

(X) theoretical ratio calculated from tank geometry

(X) interpolation from tank manufacturer's chart

( ) other (describe briefly) _____

( ) not applicable; volume measured directly

How is the coefficient of thermal expansion (Ce) of the product determined?

( ) product sample taken for each test and Ce determined from specific gravity

(X) value supplied by vendor of product

(X) average value for type of product

( ) other (describe briefly) _____

How is the leak rate (gallon per hour) calculated?

( ) average of subsets of all data collected

( ) difference between first and last data collected

( ) from data of last _____ hours of test period

(X) from data determined valid by statistical analysis

( ) other (describe briefly) _____

What threshold value for product volume change (gallon per hour) is used to declare that a tank is leaking?

( ) 0.05 gallon per hour

( ) 0.10 gallon per hour

( ) 0.20 gallon per hour

(X) other (list) 0.058 gal/h _____

Under what conditions are test results considered inconclusive?

( ) ground-water level above bottom of tank

( ) presence of vapor pockets

(X) too much variability in the data (standard deviation beyond a given value)

( ) unexplained product volume increase

( ) other (describe briefly) _____

Exceptions

Are there any conditions under which a test should not be conducted?

( ) ground-water above bottom of tank

( ) presence of vapor pockets

(X) large difference between ground temperature and delivered product temperature

( ) high ambient temperature

( ) invalid for some products (specify) _____

( ) other (describe briefly) _____

What are acceptable deviations from the standard testing protocol?

(X) none

( ) lengthen the duration of test

( ) other (describe briefly) _____

What elements of the test procedure are determined by testing personnel on-site?

( ) waiting period between filling tank and beginning test

( ) length of test

( ) determination of presence of vapor pockets

( ) determination that tank deformation has subsided

( ) determination of "outlier" data that may be discarded

( ) other (describe briefly) _____

(X) none