# Test Procedures for Comparison

# of Different ATGS Probes

**Prepared for General Use by Ken Wilcox Associates, Inc.**
**March 27, 2000**

Copies of this protocol may be obtained from KWA, Inc. at http://www.kwaleak.com

# Test Procedures for Comparison of Different ATGS Probes

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March27, 2000

## Preface

Vendors of leak detection equipment continue to improve the design and performance of their leak detection systems. In particular, the probes for Automatic Tank Gauging Systems (ATGS) have continued to improve. This document was prepared to describe procedures that can be used to compare the performance of two probes when connected to a single console. The test procedures used are similar to those described in the EPA protocol “Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems”.

Ken Wilcox Associates, Inc.

March 27, 2000

## Disclaimer

The procedures described in this document are different than those in EPA's Standard Protocols. Users are cautioned that although this alternative protocol may have been reviewed and accepted by some regulatory agencies, this does not mean that all agencies will necessarily find it acceptable. All regulatory agencies within the geographic area of application should be contacted prior to testing to assure that the results will be acceptable. KWA, Inc. makes no statement regarding the applicability, acceptability, or quality of results that may be obtained by other users, nor do we guarantee that any individual regulator or agency will accept the results.

Users of this test protocol should note that the NWGLDE[1] only reviews evaluations done by an independent third party. This protocol may be implemented by anyone to compare the performance of two probes. However, the NWGLDE will not review the results unless the evaluation is done by an independent third party.

[1] In 1994, the EPA established the National Work Group for Leak Detection Evaluations which consists of a group of State and Federal Regulators that review leak detection evaluations, new evaluation protocols, and other issues affecting the leak detection and underground storage tank industry.

**Acknowledgments**

This document has been prepared by Ken Wilcox Associates, Inc. for use by anyone who wishes to compare the performance of two probes when connected to the same controller. The effort was funded entirely by KWA, Inc. Portions of this document were written by Ken Wilcox, Jerry Flora, and Jeff Wilcox.

Helpful discussions were obtained from Mr. Brad Davis, Emco Electronics, Ms. Beth DeHaas, Maine Department of Environmental Protection, and Mr. Jon Reeder, Florida Department of Environmental Protection. Their assistance is gratefully acknowledged.

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# 1.0 INTRODUCTION

## 1.1 Background

Vendors of leak detection equipment continue to improve the design, construction, and performance of their equipment. There has been little or no guidance on how these changes should be handled in terms of their third-party evaluations. Although undergoing a complete re-evaluation of the equipment is one satisfactory approach, the cost and inconvenience tend to discourage most vendors from making improvements in their equipment.

An alternative approach is to conduct limited testing of the new component against the original model to determine if the performance of the new hardware is at least equal to the original equipment. However, the primary objective of evaluating systems with new components is to assure that the system will perform adequately and consistently in the same manner that the original system did. Evaluation of individual system components by themselves, while giving some indication of how a system may perform, is not sufficient to assure that a particular system will perform adequately.

## 1.2 Applicability

This protocol has been developed specifically for comparison of the performance of two or more probes when attached to the same controller. One of the probes used in the comparison testing must have been evaluated using the standard EPA ATGS protocol.[1] If the performances of the new probe(s) are at least as good as the probe used in the original evaluation, the substitution of the new probe(s) for the original probe can be accomplished without any further testing. Satisfactory performance as part of the original system does not mean the new probe(s) may be substituted for the original probe in a system that was not part of the comparison evaluation.

The performance specifications and limitations of the original evaluation will remain in effect for all probes. Evaluation under this protocol will not be sufficient to allow changes in the system performance that was determined in the original evaluation (i.e. maximum applicable tank size, required stabilization times, test times, probability of detection, probability of false alarm, leak rate, leak threshold, etc. These will remain the same as determined by the original evaluation.

[1] Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems (ATGS), EPA/530/UST-90/006 March 1990.

## 2.0 GENERAL APPROACH

In general, the procedures described in this document are those contained in the EPA protocol for automatic tank gauging systems.[2] The primary difference is that the testing has been limited to twelve tests rather than 24 required by the EPA protocol. A full description of the product levels, temperature differences, and induced leak rates required for the probe comparison evaluation is described in Section 6.0.

The tank system used for the comparison should be stable prior to the start of the evaluation. This is to allow the probes to be setup properly without complications caused by mechanical agitation or thermal effects. Probes should be setup by the vendor or according to the vendor's instructions using the same techniques that are normally used at a site. Preliminary testing should be conducted before starting the evaluation to assure that both probes are working properly and are reporting the same basic information.

Product deliveries, temperature differentials, and leak simulations are then conducted with the original probe and the new probe(s) connected to the same controller. The results reported by the controller from both probes are then compared to each other. If the results for both probes are not significantly different, then the new probe can be used with the original controller using the results from the original evaluation without any further testing.

Note: Throughout this document, the probe that was evaluated previously using the full EPA ATGS evaluation protocol will be referred to as the "original probe". The probe that is being compared to the "original probe" will be referred to as the "new probe".

[2] Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems (ATGS), EPA/530/UST-90/006 March 1990.

## 3.0 EVALUATION TANK

Any underground tank can be used that allows the probes to be compared to be physically located together and can be structured for normal test conditions. An underground tank that can be removed from routine service can be used for these comparisons.

The tank used in the probe comparison testing should be the same size or larger than the tank used in the original evaluation. However, regardless of the size of the tank used in the probe comparison testing, the maximum applicable tank size of the system with the new and the original probes will remain the same as that determined in the original evaluation.

## 4.0 PRODUCT

Any hydrocarbon product of grade number 2 or lighter may be used. Acceptable products include gasoline, no. 2 diesel fuel, aviation fuel, Jet-A, JP-4, JP-5, JP-8 or kerosene. Other products may also be acceptable. Highly viscous materials such as motor oil should not be used unless the leak detector is designed to test that product only and the original evaluation was done with the same type of product.

## 5.0 LEAK SIMULATION EQUIPMENT

The induced leak procedures are identical to those described in the standard EPA protocols for ATG and volumetric systems. A peristaltic pump is used to produce the leak. The volume of product removed from the tank over a specified time period is used to determine the induced leak rate. The volume of product removed during the test can also be determined volumetrically.

## 6.0 EVALUATION PROCEDURES

All of the procedures described in the standard protocol are applicable to the comparison testing. The experimental design is indicated in Table 6.1 for an evaluation conducted under conditions where the tank is filled to 90-95% capacity for two tests and then reduced to 50% for two additional tests.

**Table 6.1 Standard Testing - Product Volume, Leak Rate, and Temperature Differential Test Schedule**

| Test Description | Test No. | Pair No. | Set No. | Nominal leak rate (gallon per hour) | Nominal temperature differential (degree F) |
|---|---|---|---|---|---|
| Trial run | - | - | - | 0.00 | 0 |
| Empty to 50% full (if applicable) | | | | | |
| Refill to 90-95% | 1 | 1 | 1 | LR1 | T3 |
| | 2 | 1 | 1 | LR2 | T3 |
| Empty to 50% | 3 | 2 | 1 | LR2 | T3 |
| | 4 | 2 | 1 | LR1 | T3 |
| Refill to 90-95% | 5 | 3 | 2 | LR2 | T1 |
| | 6 | 3 | 2 | LR1 | T1 |
| Empty to 50% | 7 | 4 | 2 | LR2 | T1 |
| | 8 | 4 | 2 | LR2 | T1 |
| Refill to 90-95% | 9 | 5 | 3 | LR2 | T2 |
| | 10 | 5 | 3 | LR2 | T2 |
| Empty to 50% | 11 | 6 | 3 | LR1 | T2 |
| | 12 | 6 | 3 | LR2 | T2 |

## 6.1 Product Levels and Temperature Differentials

Three cycles of four tests with the first two tests done with tank 95% full and the second two done with the tank 50% full should be used for the evaluation. Each of the three test cycles starts with the addition of product to the tank – filling it from 50% to 90-95% full. For one cycle the product should be the same temperature (T1) as the product in the test tank, for the other two the product should be 5 degrees F cooler (T2) and 5 degrees F warmer (T3). The order of T1, T2, and T3 should be assigned randomly.

## 6.2 Determination of the Temperature Differential Values

The temperature differential can be determined using either thermal balance equation or by the difference between the average temperature of the product in the test tank before transfer and the temperature of the incoming product, if it is known. If the temperature of the product added to the test tank is not known, the temperature difference can still be determined using the thermal balance equation if the following variables are known:

- Temperature of Product in Test Tank Before Adding Product ($T_{Before}$)
- Temperature of Product in Test Tank After Adding Product ($T_{After}$)
- Volume of Product in the Test Tank Before Adding Product ($V_{Before}$)
- Volume of Product in Test Tank After Adding Product ($V_{After}$)

Using the variables above, the temperature differential can be calculated using the equations below. $T_{Delivery}$ and $V_{Delivery}$ are the temperature and volume of the product added to the test tank. $T_{Differential}$ is the temperature differential between the product added to the test tank and the product in the test tank before the delivery.

(1) $T_{Delivery} = [(T_{After} * V_{After})] – [(T_{Before} * V_{Before})] / V_{Delivery}$

(2) $T_{Differential} = T_{Delivery} - T_{Before}$

## 6.3 Induced Leak Rates

The evaluator may chose to follow either of the two options described below. The first option uses only two leak rates – 0 gph and either 0.1 gph or 0.2 gph. The second option includes 4 leak rates and follows the ATG protocol closely. If a vendor thinks they might like to continue with a full ATG evaluation after reviewing the results from the 12 tests in this probe evaluation then the second option should be used. A full evaluation (24 tests) following ATG protocol would be required if a vendor wanted to reduce waiting time or test time or increase the size of the tank an ATG could be used to test.

### 6.3.1

OPTION 1 - Leak rates of 0.0 gal/h and 0.2 gal/h should be used to evaluate a system's ability to detect a 0.2 gal/h leak rate. Leak rates of 0.0 gal/h and 0.1 gal/h should be used to evaluate a system's ability to detect a 0.1 gal/h leak rate.

The nominal leak rates chosen should reflect the leak rates used in the original evaluation. Four tests using a 0.0 gal/h leak rate and eight tests using either 0.2 gal/h or 0.1 gal/h leak rate should be used in the evaluation LR1 and LR2 should be assigned randomly but a 0.0 gph leak rate should be included in each of the 3 empty/fill cycles in Table 1.

0PTION 2 - To evaluate a system's ability to detect a leak of 0.1 gph, leak rates of 0.0 gph, 0.05 gph, 0.1 gph and 0.2 gph should be used. To evaluate a system's ability to detect a 0.2 gph leak, leak rates of 0.0 gph, 0.1 gph, 0.2 gph and 0.3 gph should be used. These leak rates are represented by LR1, LR2, LR3 and LR4 in TABLE 2. Leak rates should be assign as randomly as possible but at least one of each leak rate should be included in each empty/fill cycle (T1, T2, T3) and at each level (50% and 95% full).

**Table 6.2 Standard Testing - Product Volume, Leak Rate, and Temperature Differential Test Schedule**

| Test Description | Test No. | Pair No. | Set No. | Nominal leak rate (gallon per hour) | Nominal temperature differential (degree F) |
|---|---|---|---|---|---|
| Trial run | - | - | - | 0.00 | 0 |
| Empty to 50% full (if applicable) | | | | | |
| Refill to 90-95% | 1 | 1 | 1 | LR1 | T3 |
| | 2 | 1 | 1 | LR2 | T3 |
| Empty to 50% | 3 | 2 | 1 | LR3 | T3 |
| | 4 | 2 | 1 | LR4 | T3 |
| Refill to 90-95% | 5 | 3 | 2 | LR4 | T1 |
| | 6 | 3 | 2 | LR3 | T1 |
| Empty to 50% | 7 | 4 | 2 | LR2 | T1 |
| | 8 | 4 | 2 | LR1 | T1 |
| Refill to 90-95% | 9 | 5 | 3 | LR3 | T2 |
| | 10 | 5 | 3 | LR4 | T2 |
| Empty to 50% | 11 | 6 | 3 | LR2 | T2 |
| | 12 | 6 | 3 | LR1 | T2 |

## 6.4 Stabilization Times

Wait times and test times used for this evaluation should be the same as or less than the average of the wait and test times used in the original evaluation. If wait times during the original evaluation varied by more than 100% then the median wait times may be used. If wait and/or test times in the original evaluation were determined by the ATG based on analysis of level and temperature information (volumetric systems only) then the same process may be used in this evaluation.

The vendor normally specifies the stabilization time between the last significant delivery or removal from the tank. The criteria for determining when the tanks has reached sufficient stability for testing should be specified by the vendor in a form that will allow the evaluator to determine when the criteria have been met during the evaluation. Attempting to collect data for comparison purposes too soon after a product transfer could result in erratic results.

## 6.5 Summary of Evaluation Procedures

A brief description of the procedures is as follows.

1. The leak detector is installed in the tank per the vendor's instructions.
2. A trial test is conducted to determine that the equipment and tank are behaving as expected.
3. The tank is emptied (if necessary) to 50% of capacity and refilled to 90-95% with temperature conditioned product. For the testing described in this document the temperature would be 0 or ±5 deg F.
4. The temperature differential is determined by measuring the relative difference in the temperature of the product in the tank and the incoming product temperature.
5. The tank is allowed to stabilize prior to the test for the time period specified by the vendor.
6. The first test is conducted according to the vendor's instructions with the induced leak rate specified in the test matrix.
7. A second test is conducted immediately after the first with the induced leak rate specified in the test matrix and with the product level still at the 90% level.
8. The product is lowered to the 50% level and a third test is conducted with the induced leak rate specified in the test matrix.
9. A fourth test is conducted immediately after the third with the induced leak rate specified in the test matrix and with the product level still at the 50% level.
10. The tank is then refilled to the 90-95% of capacity with the temperature differential specified in the test matrix and steps 5 through 9 are repeated twice with different temperature differentials.
11. The data for each test are recorded on individual test log forms.

## 7.0 WATER SENSOR EVALUATION

If the water sensor used in the new probe is a float system and no changes have been made from the original probe then additional testing is not necessary and the results of the original evaluation can be used.

If the probe uses ultrasonic technology to detect water or if changes were made in the water detection portion of the new probe then additional testing is necessary. Follow the instructions given in EPA's Standard Test Procedure for Evaluating Leak Detection Methods – Automatic Tank Gauging Systems. See sections 5.5, 6.4, 7.2. and the Reporting Form for Water Sensor Evaluation Data.

The evaluator should examine both the original and new probes to determine if additional testing is required.

## 8.0 ENVIRONMENTAL DATA RECORDS AND ATGS CONTROLLER PRINTOUTS

The forms in Attachment B should be used to record the environmental conditions that are present during the evaluation. Weather station data may be used if available. Precautions should be taken to avoid collecting data when the weather conditions are unstable and could contribute to unnecessary noise.

The information for all tests should be recorded and included in the final report even if the results are inconclusive. If a test run is judged invalid during testing then follow the instructions in section 6.3 of EPA's Standard Test Procedure for Evaluating Leak Detection Methods – Automatic Tank Gauging Systems to determine the procedures to follow (except that a minimum of 12 valid tests, not 24, must be run).

A copy of the ATGS controller printouts with the results reported for each probe should be attached to the forms in Attachment B.

## 9.0 DATA ANALYSIS

The comparison of the leak rates from the different probes should be done using the null hypotheses for the difference in means using small independent samples from normal populations. Basically, the null hypotheses is a comparison of the mean of the leak rate results from each probe (original vs. new) that determines whether the results from the new system are at least as good as the results from the old system.

A data set of leak rates using both the original probe and the new probe is generated under identical conditions with their data signals being processed by the same software algorithm. Unless otherwise determined or suspected, it is to be accepted that these two sets are small independent samples from normal populations with equal (but unknown) standard deviations. The concept is to compare these two sets of small-sample data to determine if they demonstrate a statistically significant difference and, consequently, are not producing equivalent leak rate results.

The data obtained can be summarized in Table 9.1, which assumes 12 tests. Additional rows could be added for additional tests.

**Table 9.1 Data Form for Recording Probe Comparison Leak Results**

| Test Number | Leak Rate Probe S (Original) | Leak Rate Probe B (New) | Induced Leak Rate |
|---|---|---|---|
| 1 | | | |
| 2 | | | |
| 3 | | | |
| 4 | | | |
| 5 | | | |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |
| 11 | | | |
| 12 | | | |

The procedure for determining if there is a significant difference in the data being produced by the two probes is summarized below.

## 9.1 Determination of Significant Difference Based on Mean Reported Leak Rates

The calculations below determine if there is a difference in the mean leak rate as estimate from the original probe and the new probe.

1. Calculate the average leak rate value reported for the original probe (Set S) and the new probe (Set B.) The formulas for these averages are given below. The subscripts s and b indicate the data set and the subscript i indicates the test number. The summation is over all tests.

$$m_s = \Sigma X_{si}/n_s$$

$$m_b = \Sigma X_{bi}/n_b$$

2. Calculate the variance for Set S and Set B. The formula for the variance is given next.

$$S^2_s = \Sigma (X_{si} - m_a)^2 /(n_s - 1)$$

$$S^2_b = \Sigma (X_{bi} - m_b)^2 /(n_b - 1)$$

3. Calculate the pooled variance between Set S and Set B. The pooled variance is given by

$$S^2_p = [ (n_s - 1)S^2_s + (n_b - 1)S^2_b]/(n_s + n_a - 2)$$

4. Calculate a t-statistic to test the null hypothesis that the mean leak rates from the two probes are the same. This t-statistic is

$$t = (m_s - m_b) / (1/n_s + 1/n_b)^{0.5} S_P$$

5. Compare the absolute value of the t-statistic in step 4 to the value from the t-table. This is 2.074 for a test at the two-sided 5% significance level, assuming that there were 12 tests in each group.

6. If the absolute value of t is less than or equal to 2.074 (or the corresponding value from the t-table) there is no evidence that the mean leak rates from the two probes were different. Conclude that the new probe is not statistically different from the original probe and can be substituted for it.

7. If the absolute value of t is greater than 2.074 (or the corresponding value from the t-table) conduct the calculations described in Section 9.2.

## 9.2 Determination of Significant Difference Based on Actual Induced Leak Rate

The calculations described in this section are only necessary if it was determined that there is evidence that the mean leak rates from the two probes were different using the calculations described in section 9.1. If it was determined that there is no evidence that the mean leak rates from the two probes were different, proceed to Section 9.3.

It is possible that the new probe could be statistically different from the original probe because it produces significantly better results than the original probe. That is, the new probe might produce leak rates that match the actual leak rates better than the original probe. Since the performance of the system is judged on the ability of the system to produce leak rate estimates that closely match the actual induced leak rates, it may be preferable to compare the results of the two probes on the basis of how well they match the induced leak rates. The procedure to do this is presented below.

Comparison on the basis of matching the induced leak rates.

1. Referring to Table 9.1, form the difference between the measured leak rate and the induced leak rate for the original probe. Denote the measured leak rates by L with subscript a for actual leak rate and s for the original probe.

   $$D_{si} = L_{si} - L_{ai}$$

2. Similarly, form the differences between the measured leak rate and the induced leak rate for the new probe (denoted by b).

   $$D_{bi} = L_{bi} - L_{ai}$$

3. Compute the variances of these sets of differences using the formula below, where the index j takes the value s for the original probe or b for the new probe. That is, use the formula below separately to get the variance for each set of differences.

   $$S^2_j = \Sigma (D_{ij} - m_j)^2 /(n - 1)$$

   for j = S or B.

4. Form an F-ratio by dividing the variance from the new probe by the variance of the original probe.

   $$F = S^2_b/S^2_s$$

5. Using a 5% significance level, test the hypothesis that the two variances are equal against the one-sided hypothesis that the variance of the new probe is greater than that of the original probe. To do this compare the value of F to the upper 5% significance point of an F-distribution with (n - 1) degrees of freedom in

the numerator and the denominator. This value is 2.82 for 11 degrees of freedom for both variances.

6. If $F \leq 2.82$, (or the corresponding F-value for different degrees of freedom), conclude that the results from the new probe are at least as good as those from the original probe. Consequently, the new probe may be substituted for the original probe.

7. If $F > 2.82$, (or the corresponding F-value for different degrees of freedom), conclude that the results from the new probe are significantly different from those of the original probe. Consequently, the new probe should be re-evaluated using the standard EPA evaluation protocol for ATGS's.

The procedure described above compares the variances for the new probe to those from the original probe, using the differences between the measured and actual leak rates. By comparing the measured vs. the induced leak rate variances from the new and the original probes, this analysis determines if the new probe performs as well as or better than the original probe.

9.3 Water Detection Mode (if applicable)

The calculations for a bulk tank water detector are identical to those described in the standard ATGS protocol. The results must be applied to each particular tank geometry for which the method is used.

9.4 Tank Size Limitations

Since this evaluation applies only to comparison of probe results, there are no size limitations determined during this evaluation. If the probes are found to provide results that are not statistically different (or the new probe is better), the probe can be used on tank sizes specified in the original evaluation.

9.5 Basic Statistics

The calculations of basic statistics are the same as those described in the standard ATGS protocol sections 7.1.1 through 7.1.3. The exception to this is that the number of data sets used in the evaluation will be 12 instead of 24. The number of data sets is used to define MSE, Bias, SD, t-statistic, Pd and Pfa. Also the appropriate leak rate, either 0.1 gph or 0.2 gph should be used. These calculations need to be done separately on both the results from the new probe and from the original probe. If either probe does not achieve a $Pd \geq 95\%$ and a $Pfa \leq 5\%$ then there is not significant statistical justification for using the new probe with the originally evaluated system.

## 10.0 REPORTING OF RESULTS

The results should be reported on official forms in Attachment A.

The results of all tests should be included in the Reporting Form for Leak Rate Data. Any inconclusive test results should be explained in the Additional Comments section of the Individual Test Data Log.

If the water sensor required re-evaluation then the results should be submitted on the Reporting Form for Water Sensor Evaluation Data. Follow the instructions given in EPA's Standard Test Procedure for Evaluating Leak Detection Methods – Automatic Tank Gauging Systems.

A copy of the Results of U.S. EPA Standard Evaluation, Automatic Tank Gauging System form from the original evaluation should be included in the final report.

# Attachment A

# Standard Results Forms for Alternative Test Procedures

# “Comparison of Performance for Two or More ATGS Probes”

Results of Alternative Test Procedures

# Comparison of Performance of Two or More ATGS Probes

This form describes the performance of the leak detection method described below. The evaluation was conducted by the equipment manufacturer or a consultant to the manufacturer according to a modification of the U.S. EPA's "Standard Test Procedure for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems. The comparison testing conducted for this evaluation was done to determine if the ATGS probe described below may be used with a system that was evaluated previously with a different ATGS probe using standard EPA evaluation procedures.

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.

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## ATGS/Probe Description

Name _____

Version Number _____ Probe #/name _____

Vendor _____

_____
(street address)

_____
(city) (state) (zip) (phone)

---

## ATGS Original Evaluation

Name _____

Version Number _____ Probe #/name _____

Report Number _____

Report Title and Date _____

_____

Evaluator _____

Maximum Tank Volume _____ gallons

Leak Rate _____ gal/h Threshold _____ gal/h

Probability of Detection _____ % Probability of False Alarm _____ %

Stabilization Time ____ hours _____ min. Test Time _____ hours _____ min.

Description of Evaluation _____

_____

Name of ATGS _____

Version _____

Date of Probe Comparison Evaluation _____

Date of Original Evaluation _____

## Test Conditions During the Probe Comparison Evaluation

The probe comparison evaluation testing was conducted in a_____ gallon ( ) steel ( ) fiberglass ( ) concrete tank that was ( ) horizontal ( ) vertical and was _____ feet in diameter and _____ feet ( ) long ( ) tall.

The temperature differences between product added to fill the tank and product already in the tank ranged from _____ deg F to _____ deg F.

The tests were conducted with the tank product levels _____ and _____ % full.

The product used in the evaluation was _____ .

## Limitations on the Results

The limitations on the results of this method are those described in the original ATGS evaluation unless otherwise stated below.

_____

_____

## Water Sensor Results

If the water sensor used on the original probe is a float system and no changes have been made in the water detection portion of the new probe, then additional testing was not necessary and the results of the original evaluation should be used. If the probe uses ultrasonic technology to detect water or changes were made in the water detection portion, then additional testing was necessary and the results below should be used. Please check one:

( ) Comparison of the water sensor portion of the original probe and the new probe indicates a float system is used and no changes have been made. Results of the original evaluation are described below.

( ) Comparison of the water sensor portion of the original probe and the new probe indicates the probes use ultrasonic technology to detect water or changes have been made in the water detection portion of the new probe. Results of the additional evaluation work required are described below.

The minimum water level (threshold) that the ATGS can detect is _____ inches.

The minimum change in water level that the ATGS can detect is _____ inches (provided that the water level is above the threshold).

Name of ATGS _____

Version _____

Date of Probe Comparison Evaluation _____

Date of Original Evaluation _____

## Statement of Probe Comparison Results

There ___ was ___ was not a significant difference between the mean reported leak rates from the original probe and the new probe. (t = ____)
The new probe performed ___ as well as or better than ____worse than the original probe in measuring leaks. (F= ____)The ATGS system with the new probe, which declares the tank to be leaking when the measured leak rate exceeds the threshold of _____gph, has a probability of false alarms [P(FA)] of ____%. The corresponding probability of detection of a ___0.20 gph ___0.1 gph leak is ____%.
Based on the results of this evaluation, the ATGS system with the original probe, which declares the tank to be leaking when the measured leak rate exceeds the threshold of _____gph, has a probability of false alarms [P(FA)] of ____%.
The corresponding probability of detection of a ___0.20 gph ____ 0.1 gph leak is ___%.

The results of the probe comparison indicates that there ( ) is ( ) is not significant statistical justification for using the new probe with the originally evaluated system

> **Safety disclaimer: This test procedure only addresses the issue of the Leak Detection Method'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.

| | |
|---|---|
| (printed name) | (organization performing evaluation) |
| (signature) | (city, state, zip) |
| (date) | (phone number) |

## Reporting Form for Leak Rate Data
# Comparison of Performance for Two or More ATGS Probes

ATGS Name and Version _____

Evaluation Period: from _____ to _____

| Test No. | Date Last Fill Completed (d-m-y) | Time Last Fill Completed (military) | Date Test Began (d-m-y) | Time Test Began (military) | Time Test Ended (military) | Time Between Last Fill and Start of Test (military) | Data Collection Time (military) | Product Temperature Differential (deg F) | Nominal Leak Rate (gal/h) | Induced Leak Rate (gal/h) | Original Probe Measured Leak Rate (gal/h) | New Probe Measured Leak Rate (gal/h) | Original Probe Meas.-Ind. Leak Rate (gal/h) | New Probe Meas.-Ind. Leak Rate (gal/h) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | | | | | |
| 2 | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | |
| 4 | | | | | | | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| 6 | | | | | | | | | | | | | | |
| 7 | | | | | | | | | | | | | | |
| 8 | | | | | | | | | | | | | | |
| 9 | | | | | | | | | | | | | | |
| 10 | | | | | | | | | | | | | | |
| 11 | | | | | | | | | | | | | | |
| 12 | | | | | | | | | | | | | | |

Average Stabilization Time =

Average Data Collection Time =

# Attachment B

# Test Logs for ATGS Probe Comparison Evaluation And Water Sensor Evaluation

ATGS Name and Version: _____

Test No. _____ Date of Test _____

Name of Field Operator _____ Signature _____

**Individual Test Log**

# ATGS Probe Comparison Evaluation

**Instructions:**
Use one log for each test. Fill in the blanks and check the boxes, as appropriate. Keep test log even if test is inconclusive.

## 1.0 General Background Information

Product Type _____

Type of Tank _____

Tank Dimensions (nominal)

Diameter _____ inches Length _____ inches Volume ____ gallons

Ground-water level ___ inches above bottom of tank

If applicable, recommended stabilization period before test (per vendor SOP)

_____ Hours _____ Minutes

## 2.0 Leak Detection Test Times

Start of test data collection _____ Date _____ military time

Endo of test data collection _____ Date _____ military time

## 3.0 Product Level and Temperature Information

| | Product Level (inches) | Product Volume (gallons) | Product Temp (deg F) | Water Level (inches) | Water Volume (gallons) |
|---|---|---|---|---|---|
| Before Adding Product | | | | | |
| After Adding Product | | | | | |
| Start of Test | | | | | |
| End of Test | | | | | |

ATGS Name and Version: _____

Test No. _____ Date of Test _____

Name of Field Operator _____ Signature _____

## 4.0 Product Delivery Information

| | |
|---|---|
| Date and Time at Start of Delivery | |
| Date and Time at End of Delivery | |
| Amount of Product Added (gallons) | |
| Temperature of Product Added (deg F) | |
| Number of Tests Completed Since the Delivery Including This Test (e.g. – If this is the 2nd test following a delivery, write 2 in the table.) | |

## 5.0 Weather Information

| | Temperature (deg F) | Barometric Pressure (mm or in Hg) | Wind Conditions (none, light, moderate, or heavy) | Precipitation (none, light, moderate, or heavy) | Sky Conditions (sunny, partly cloudy, cloudy, night) |
|---|---|---|---|---|---|
| Start of Test | | | | | |
| End of Test | | | | | |

## 6.0 Leak Rate Data

| | |
|---|---|
| Nominal Leak Rate (gal/h) | |
| Induced Leak Rate (gal/h) | |
| Vendor's Reported Leak Rate (gal/h) | |
| Difference (Reported minus Induced) | |

## 7.0 ATGS Controller Printout

Attach a copy of the ATGS controller printout with the vendor's reported leak rate to this form (Attach additional pages if needed).

Additional Comments (Attach additional pages if needed)

**Reporting Form for Water Sensor Evaluation Data**

# Automatic Tank Gauging System

ATGS Name and Version: _____

Date of Test: _____ Name of Field Operator: _____

Product Type: _____ Signature of Field Operator: _____

Test No. _____

| Increment No. | Volume of Water Added (ml) | Sensor Reading (inch) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |
| 6 | | |
| 7 | | |
| 8 | | |
| 9 | | |
| 10 | | |
| 11 | | |
| 12 | | |
| 13 | | |
| 14 | | |
| 15 | | |
| 16 | | |
| 17 | | |
| 18 | | |
| 19 | | |
| 20 | | |
| 21 | | |
| 22 | | |
| 23 | | |
| 24 | | |
| 25 | | |
| Total Volume (ml) | | |

| Calculated Minimum Detectable Water Level (inches) |
|---|
| |

Note: This form provides a template for data reporting. Since the number of increments is not known from the start, the length of the report form will vary from test to test.

**Reporting Form for Water Sensor Evaluation Data**

# Automatic Tank Gauging System

ATGS Name and Version: _____

Date of Test: _____ Name of Field Operator: _____

Product Type: _____ Signature of Field Operator: _____

Test No. _____

| Increment No. A | Volume of Water Added (ml) B | Calculated Water Height Increment, h (in) C | Sensor Reading (in) D | Measured Sensor Increment (in) E | Increment Difference Calc.-Meas. (in) C - E |
|---|---|---|---|---|---|
| Minimum water level detected, X: inches (from page 1) | | | | | |
| 1 | | | | | |
| 2 | | | | | |
| 3 | | | | | |
| 4 | | | | | |
| 5 | | | | | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |
| 11 | | | | | |
| 12 | | | | | |
| 13 | | | | | |
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| 18 | | | | | |
| 19 | | | | | |
| 20 | | | | | |
| 21 | | | | | |
| 22 | | | | | |
| 23 | | | | | |
| 24 | | | | | |
| 25 | | | | | |

Note: This form provides a template for data reporting. Use as many pages as necessary.

**Reporting Form for Water Sensor Evaluation Data**

# Automatic Tank Gauging System

ATGS Name and Version: _____

Date of Test: _____ Name of Field Operator: _____

Product Type: _____ Signature of Field Operator: _____

Test No. _____

| Increment No. A | Volume of Water Added (ml) B | Calculated Water Height Increment, h (in) C | Sensor Reading (in) D | Measured Sensor Increment (in) E | Increment Difference Calc.-Meas. (in) C - E |
|---|---|---|---|---|---|
| Minimum water level detected, X: inches (from page 1) | | | | | |
| 26 | | | | | |
| 27 | | | | | |
| 28 | | | | | |
| 29 | | | | | |
| 30 | | | | | |
| 31 | | | | | |
| 32 | | | | | |
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| 40 | | | | | |
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| 42 | | | | | |
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| 45 | | | | | |
| 46 | | | | | |
| 47 | | | | | |
| 48 | | | | | |
| 49 | | | | | |
| 50 | | | | | |

Note: This form provides a template for data reporting. Use as many pages as necessary.

**Reporting Form for Water Sensor Evaluation Data**

# Automatic Tank Gauging System

ATGS Name and Version: _____

Date of Test: _____ Name of Field Operator: _____

Product Type: _____ Signature of Field Operator: _____

Test No. _____

| Increment No. A | Volume of Water Added (ml) B | Calculated Water Height Increment, h (in) C | Sensor Reading (in) D | Measured Sensor Increment (in) E | Increment Difference Calc.-Meas. (in) C - E |
|---|---|---|---|---|---|
| Minimum water level detected, X: inches (from page 1) | | | | | |
| 51 | | | | | |
| 52 | | | | | |
| 53 | | | | | |
| 54 | | | | | |
| 55 | | | | | |
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Note: This form provides a template for data reporting. Use as many pages as necessary.