EVALUATION OF THE MARLEY PUMP COMPANY MAGNETOSTRICTIVE NETWORK CARD FOR THE PROLINK SYSTEM

CERTIFICATION UNDER THE ATGS AND VOLUMETRIC CRITERIA

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OCTOBER 31,1996

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EVALUATION OF THE MARLEY PUMP COMPANY MAGNETOSTRICTIVE NODE FOR THE PROLINK SYSTEM

CERTIFICATION UNDER ATGS AND VOLUMETRIC CRITERIA

Prepared for:

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October 31, 1996

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EXECUTIVE SUMMARY

The Marley Pump Company's Red Jacket Electronics Prolink System with a magnetostrictive sensor card and magnetostrictive sensor was evaluated for performance against Automatic Tank Gauging System (ATGS) and volumetric performance specifications. The Environmental Protection Agency protocols "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", Final Report, U.S. environmental Protection Agency Office of Underground Storage Tanks, EPA/530/UST-90/006, March, 1990, was modified to allow for the evaluation of the system under ATGS and volumetric criteria. The system was found to meet all performance parameters required for such devices as shown on Table I.

Table I. Evaluation Results - Magnetostrictive Node for the Marley Prolink System

Parameter	EPA ATGS Requirement	Marley Results	EPA Volumetric Requirement	Marley Results
System Threshold Leak Rate	0.1 gph	0.041 gph	0.05 gph	0.035 gph
Probability of False Alarm	< 5%	< 0.005%	< 5%	< 5%
Probability of Detecting a 0.2 (0.1 Volumetric) gph Leak	> 95%	> 99.95%	> 95%	> 95%

The Marley Pump Company has expanded their product line and re-packaged the components of the system in order to service different market segments. The Red Jacket Electronics Prolink System consists of a variable number of discrete "nodes", linked together over a common network interface. Each discrete node performs its own tasks and processes its own information and "publishes" this information onto the network for use by other nodes or network management tools. The magnetostrictive sensor card is one such node. It interfaces to the magnetostrictive sensor, processes the data, performs leak detection, and issues the test results onto the network where they may be retrieved by another node or a network management tool such as a personal computer. Under this system, the node performs leak detection independent of the other network members, but also "publishes" this information on the network. Table II shows the Marley products covered by this evaluation.

Table II. Marley Pump Company Products Covered By Evaluation

Red Jacket Electronics Prolink System Magnetostrictive Sensor Card Magnetostrictive Sensor Part Number: RE125-155

Evaluation test parameters are given in Table III.

Table III. Test Conditions During Evaluation

Parameter	Value
Number of Tests	24
Test Tank Dimensions	96" Diameter x 384" Long
Size of Test Tank	12,000 gal
Maximum Allowable Tank	18,000 gal
Product Level in Tank	50% to 95%
Product Temperature Differential Range	-8.2 °F to +6.7 °F
Average Waiting Time Before Testing	12.9 hours
Average Test Duration	4.52 hours (ATGS) 6.65 hours (Volumetric)

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SUMMARY

This report summarizes the results of an evaluation performed by ADA Technologies, Inc. (ADA) from July 29 to August 30, 1996 for The Marley Pump Company (MPC) of a system used for determining the leak rates of fluid from underground storage tanks. MPC has developed a leak detection probe and data acquisition system, which is designated by the following name and part number. Red Jacket Electronics Prolink System with a magnetostrictive sensor card and magnetostrictive sensor, part number: RE125-155, for the purpose of determining such leaks. ADA was contracted as a third-party evaluating organization to determine whether the system met performance standards established by the Environmental Protection Agency (EPA) for leak detecting equipment.

Results of the evaluation establish that the MPC system performs at a level exceeding the requirements established by the EPA for both Automatic Tank Gauging Systems (ATGS) and volumetric systems.

INTRODUCTION

The EPA has promulgated standards requiring owners and operators of underground storage tanks to check for leaks on a routine basis. In order to ensure the accuracy and effectiveness of the methods used for the determination of leak rates, the EPA has set forth minimum standards for the performance of equipment used in these determinations. In the case of a method based on the determination of leaks on a volumetric basis, the procedure for evaluating a device is found in "Standard Test Procedures for Evaluating Leak Detection Methods: Volumetric Tank Tightness Testing Methods", Final Report, U.S. Environmental Protection Agency Office of Underground Storage Tanks, EPA/530/UST-90/004, March, 1990. For Automatic Tank Gauging Systems, the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Automatic Tank Gauging Systems", Final Report, U.S. Environmental Protection Agency Office of Underground Storage Tanks, EPA/530/UST-90/006, March, 1990 is used.

In order to accommodate an evaluation under both volumetric and ATGS criteria, the ATGS test procedure was modified slightly. The modification consisted of eliminating to requirement to test at a 0.3 gph leak rate and to substitute testing at a leak rate of 0.05 gph. All other testing requirements of the standard ATGS protocol were followed.

The test procedures require that the leak detection equipment manufacturer or an independent third-party contractor perform the evaluation for determining whether the device meets performance standards. For volumetric testing systems, the system must be capable of detecting a leak of 0.10-gallon per hour with a probability of at least 95%, while operating at a false alarm rate of no more than 5%. For ATGS systems, the system must be capable of detecting a 0.2 gph leak with a probability of at least 95%, while operating at a false alarm rate of no more than 5%.

TEST PROCEDURES

The testing procedures are designed to evaluate the ability of the leak detection device to measure the leakage rate of product from a tank. A series of 24 test are performed. Leaks are artificially induced in a test tank by pumping product out of the tank using an external pump. Measurements obtained using the leak detection device are then compared with the induced leak rates using statistical methods.

An initial test (Trial Run) is performed under stable conditions to assure that the equipment is working properly, and that there is no problem with the tank being used for the evaluation. The leak detection system then determines the leak rate of the tank in a series of test runs. Nominal leak rates of 0.0, 0.05, 0.1, or 0.2-gallon per hour are induced using a pump to extract fluid from the tank. The extraction rates are accurately measured using a precision scale to weight the product. The 24 tests are performed using a randomized testing sequence, which includes procedures for transferring product in and out of the tank to simulate emptying and filling operations. One-third of the transfers are performed with heating the product during transfer into the test tank, one-third are done with cooled product, and one-third are conducted with no temperature differential of the product.

The evaluation process is completed by performing the statistical analysis outlined in the standard test procedures to compare the leak detection probe's measurements of leak rates against the actual induced volume changes for each test run.

TEST EQUIPMENT

LEAK DETECTION SYSTEM

The leak detection system (MPC designated Red Jacket Electronics Prolink System with a magnetostrictive sensor card and magnetostrictive sensor, part number: RE125-155) evaluated under the EPA Protocol was developed by The Marley Pump Company of Lenexa, Kansas. The principles of equipment operation and associated algorithms for data processing are proprietary to MPC.

An MPC employee, who was trained and knowledgeable about the construction and operation of the probes and data acquisition equipment, performed the initial field installation of the leak detection system. ADA personnel operated the equipment and collected data thereafter during the evaluation.

The Marley system is described in more detail on the standard EPA forms found in Appendix C and Appendix D.

TANK

The tank used in the evaluation is located at 2660 S. Federal Blvd., Denver, Colorado at a site operated by ProFab, Inc. (Englewood, Colorado). The tank is constructed of steel, with nominal dimensions of 96-inches in diameter by 384-inches long. The nominal capacity of the tank is 12,000-gallons. Two other tanks are located at the site, one of which was used to hold fluid during the product transferring operations. The top of the tank is positioned 20-inches below ground surface. The bottom of the tank is 116-inches below ground surface. The diameter of the tank was verified by using a graduated "stick" used for determining tank product levels. Each tank has three fill pipes.

The test procedure calls for the evaluation to be performed on a tight tank, tested to be tight using a method independent of the system being evaluated. The test must be done within the 6-months preceding the evaluation period. This test was performed on March 7, 1996. The test verified that the tank met tightness requirements. A report of the initial tightness of the tank is found in Appendix J. The tank's integrity was confirmed based on the results of the measurement of "zero leak rates" induced during the trial run and the 24 test runs.

A groundwater monitoring well is installed on the test site to determine the presence of groundwater. The well is constructed of 4-inch PVC perforated pipe, installed to a depth of 146-inches. The well is located within 53-inches of the tank used in the evaluation. A dry wooden stick was placed into the well periodically to determine whether groundwater was present. Groundwater was not found at any time.

Figure 1 is a site layout drawing showing the locations of pertinent equipment. Figure 2 is a sectional drawing showing the layout of equipment in the subsurface.

PRODUCT

The product used in the evaluation of the leak detection system was #2 Diesel fuel oil.

LEAK SIMULATION

The test procedure calls for inducing leaks in the tank. This was accomplished by using a Masterflex peristaltic pump. This pump is equipped with a variable speed adjustment to provide the range of induced leak rates required. A length of rubber tubing was placed through a fill pipe. The tubing fit into a pump head which contains rollers that press against the tubing to provide the pumping action. The pump head was loosened periodically in order to advance the tubing a few inches to provide an unused section for subsequent testing. This was done to prevent pinching of the tube which can lead to erratic or non-flow conditions.

The other end of the tubing discharged product into a plastic container placed on an analytical balance. As the container was filling with product, weights were recorded in a computer at the test site. The peristaltic pump was adjusted automatically to maintain target leak rates.

Induced volumetric leak rates were calculated by dividing the weight of product collected by the density of the product and applying appropriate conversion factors. The density of product was determined by weighing known volumes of product.

MISCELLANEOUS LEAK DETECTION MODE EQUIPMENT

The test procedure required the partial emptying and filling of the test tank. After each two test series, product was pumped from the test tank and into a holding tank. The pumping was stopped when the test tank was 50% empty. Two more tests were conducted at the 50% full level. Product was then pumped back into the test tank until the tank reached 95% capacity. The transfer was performed using a pump of approximately 70-gallon per minute capacity. Transfers of product into or out-of the test tank took approximately 90-minutes.

Heat transfer equipment was also required in order to produce the necessary product delivery temperature differentials specified in the test procedure. A heat exchanger was used for this purpose, where the product was heated or cooled using hot or cold water passing through bundles of tubes in a tube-and-shell exchanger. A boiler at the test site provided hot water for the heat transfer, and a walk-in refrigerator with a reservoir of anti-freeze was used for the cooling transfer. The heat transfer operations took place as product was being transferred back into the test tank from the holding tank.

A "T"-type thermocouple was placed in the transfer pipe carrying product to and from the test tank. The temperature of the transfer out of the tank and subsequently back in was displayed and recorded using a Campbell Scientific data logger.

The data logger was also used to display and record temperatures of product within the tank. Six "T"-type thermocouples were placed across the vertical diameter of the test tank based on an equal volume grid. The uppermost thermocouple was out of the liquid, and monitored vapor space temperature only. The remaining five thermocouples measured liquid temperatures continuously when product was in the tank at the test level. Another thermocouple was positioned in the water line entering the heat exchanger in order to monitor water temperature. Figure 3 shows the locations of the thermocouples in the test system.

TEST PLAN

A test matrix was developed in accordance with the guidelines provided in the EPA Protocols. The matrix is shown in Table I.

TEST PROCEDURE

The test sequence included the following general steps:

1. Product was transferred out of the tank until the tank was 50% full.
2. Product was pumped back into the tank after going through a heat exchanger to provide a nominal 0°, +5°, or -5°F temperature differential. Product was pumped into the tank until it was 95% full.
3. A 10-12-hour "wait" period followed before the leak detection system began acquiring data.
4. The peristaltic pump was started 1-hour before the start of the first test of a two-test sequence (i.e., the pump was started at hour 11 of the 12-hour wait period). This allowed time to adjust and stabilize the flow and to allow the tank to equilibrate to a "leaking" condition.
5. At hour 12 of the wait period, the data acquisition program of the leak detection probes was begun.
6. The leak detection probe acquired data over approximately a 4.5-hour test period for the ATGS mode, and over approximately 6.5 hours for the volumetric mode. At the end of each ATGS or volumetric test, the system would automatically log the test results. The peristaltic pump was then adjusted for any necessary induced leak rate changes required for the second test. After a short "wait", the second test of each test pair was begun. A summary of the leak rate data generated by the Marley system is given in Appendix G.
7. Data was again acquired over approximately the next 6.5-hours. Test results are logged automatically by the system.
8. Product was transferred out of the tank until the tank was 50% full.
9. Steps 3-7 were followed for the 50% full tank condition.
10. Steps 1-9 were then followed to begin the next test series at a 95% full tank.

TEST RESULTS

Results of the evaluation are analyzed in terms of the comparison of the induced leak rates with the measured leak rates determined by the leak measuring probe. A summary of the test data is shown in Appendix E. These results are subjected to statistical analysis detailed in Section 7 of the EPA Protocol document to determine the method's performance characteristics. A summary of the analysis is presented in Appendix F. Twenty-four tests were performed in total. Descriptions of the statistical performance parameters follow.

ZERO BIAS

The method bias is defined as the average difference between measured and induced leak rates covering the 24 tests performed. A t-statistic is calculated and compared with a standard value to determine whether the bias is significance. The bias was found to be significant for the system under both ATGS and volumetric criteria. The calculated bias for the leak detection method is -0.016 gph (ATGS mode) and -0.015 gph (volumetric mode).

FALSE ALARM RATE

The false alarm rate refers to the probability of declaring that a tank is leaking when in fact it is tight. A t-value is calculated from the test data and compared against a standard t-value to determine significance of the false alarm rate. The false alarm rate for the system was found to be less than 0.005% (ATGS mode) and less than 5% (volumetric mode). The performance standard specified by EPA requires that the false alarm rate should not exceed 5%.

PROBABILITY OF DETECTING LEAK RATES OF 0.1 and 0.2 GPH

This performance parameter is evaluated by calculating a t-value and determining the percent probability from the test data. ATGS systems are evaluated against the ability to measure a 0.2 gph leak, and volumetric systems are evaluated on their ability to measure a 0.1 gph leak. The probability of detection for the Marley system was found to be greater than 99.95% (ATGS mode. 0.2 gph leak) and greater than 95% (volumetric mode, 0.1 gph leak). The EPA standard specifies that this calculated probability exceed 95% for the leak detection system.

MINIMUM THRESHOLD

Minimum threshold is a parameter describing the limit of measurement of the leak detection system corresponding to a false alarm rate of 5%. For the Marley system, the minimum threshold is calculated to be 0.041 gph (ATGS mode) and 0.035 gph (volumetric mode).

MINIMUM DETECTABLE LEAK RATE

The minimum detectable leak rate is a calculated value which defines the leak detection system's measurement capability corresponding to a probability of detection of 95%. For the Marley system, the minimum detectable leak rate is calculated to be 0.083 gph (ATGS mode) and 0.070 gph (volumetric mode).

CONCLUSIONS

The Marley Pump Company Magnetostrictive Node for the Prolink System was evaluated using a modified EPA Protocol EPA/530/UST-90/004, and found to meet the standards of performance specified for ATGS and Volumetric Tank Tightness Testing Methods. The evaluation was performed on a nominal 12,000-gallon tank, tested at 50% and 95% full. A summary of the evaluation is documented on the EPA forms found in Appendix A and Appendix B.

Appendix A

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

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 prove 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: Magnetostrictive Node for the Prolink System

Version number: RE-125-155

Vendor: The Marley Pump Company
9650 Alden Road
Lenexa, KS 66215 (913) 498-5585

Evaluation Results

This ATGS, which declares a tank to be leaking when the measured leak rate exceeds the threshold of 0.1 gallon per hour, has a probability of false alarms [P(FA)] of ≤0.005%.

The corresponding probability of detection [P(D)] of a 0.2 gallon per hour leak is ≥99.95%.

The minimum water level (threshold) in the tank that the ATGS can detect is 0.106 inch.

The minimum change in water level that can be detected by the ATGS is 0.058 inch (provided that the water level is above the threshold).

Therefore, this ATGS ☒ 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 ☒ 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 12,000 gallon ☒ steel ☐ fiberglass tank that was 96 inches in diameter and 384 inches long.

The temperature difference between product added to fill the tank and product already in the tank ranged from -8.2 °F to +6.7 °F, with a standard deviation of 5.9 °F.

The tests were conducted with the tank product levels 50 and 95 % full.

The product used in the evaluation was #2 Diesel.

Name of ATGS: Magnetostrictive Mode for the Prolink System
Version: RE-125-155

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 18,000 gallons.
- The tank is at least 50 percent full.
- The waiting time after adding any substantial amount of product to the tank is 12.9 hours.
- The temperature of the added product does not differ more than 8.9 degrees Fahrenheit from that already in the tank.
- The total data collection time for the test is at least 4.52 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:

☒ standard EPA test procedure for ATGS
☐ alternative EPA test procedure for ATGS

Richard J. Schlager
(printed name)

Richard J. Schlager
(signature)

10/29/96
(date)

ADA Technologies, Inc.
(organization performing evaluation)

Englewood, CO 80112
(city, state, zip)

(303) 792-5615
(phone number)

Appendix B

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

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" and "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 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: Magnetostrictive Node for the Prolink System

Version: RE-125-155

Vendor: The Marley Pump Company
9650 Alden Road
Lenexa, KS 66215 (913) 498-5585

Evaluation Results

This method, which declares a tank to be leaking when the measured leak rate exceeds the threshold of 0.05 gallon per hour, has a probability of false alarm [P(FA)] of <5%.

The corresponding probability of detection [P(D)] of a 0.1 gallon per hour leak is >95%.

Therefore, this method ☒ 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 12,000 gallon ☒ steel ☐ fiberglass tank that was 96 inches in diameter and 384 inches long.

The tests were conducted with the tank 50 and 95 percent full.

The temperature difference between product added to fill the tank and product already in the tank ranged from -8.2 °F to +6.7 °F, with a standard deviation of 5.9 °F.

The product used in the evaluation was #2 Diesel.

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 18,000 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 12.9 hours.
- The temperature of the added product does not differ more than 8.9 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 6.65 hours.
- Large vapor pockets are identified and removed (for methods that overfill the tank).
- This method ☒ can ☐ cannot be used if the groundwater level is above the bottom of the tank, when used in conjunction with the Marley water sensor attached to the probe.
- Other limitations specified by the vendor or determined during testing:

> **Safety disclaimer: This test procedure only addresses the issue of the method'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 automatic tank gauging systems and that the results presented above are those obtained during the evaluation.

Richard J. Schlager (printed name)	ADA Technologies, Inc. (organization performing evaluation)
Richard J. Schlager (signature)	Englewood, CO 80112 (city, state, zip)
10/29/96 (date)	(303) 792-5615 (phone number)

Appendix C

Description, Automatic Tank Gauging System

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

The Marley Pump Company Magnetostrictive Node for the Prolink System
Version RE-125-155

Product

> Product type

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

- ☒ gasoline
- ☒ diesel
- ☒ aviation fuel
- ☒ fuel oil #4
- ☒ fuel oil #6
- ☒ solvents
- ☒ waste oil
- ☒ other (list) Any liquid that is compatible with the probe and whose temperature characteristics can be determined.

> Product level

What product level is required to conduct a test?

- ☐ greater than 90% full
- ☐ greater than 50% full
- ☒ other (specify): from 15 inches of product to 95% full.

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

- ☒ yes When used in conjunction with the Marley water sensor attached to the probe
- ☐ no

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

- ☒ yes When used in conjunction with the Marley water sensor attached to the probe
- ☐ 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
- ☒ changes 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
- ☒ 5 or more sensors
- ☐ temperature-averaging probe

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

- ☒ resistance temperature detector (RTD)
- ☐ bimetallic strip
- ☐ quartz crystal
- ☐ thermistor
- ☐ other (describe briefly)

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

- ☐ 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
- ☒ 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
- ☐ 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
- ☐ variable (explain)

> Total time

What is the total time needed to test with this ATGS after a delivery?
(waiting time plus testing time)
16 hours 24 minutes

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

- ☒ 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 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):
- ☐ 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?

- ☒ 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?

- ☒ wait a specified period of time before beginning a 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
- ☒ no

If not, how often are the sensors calibrated?

- ☐ weekly
- ☐ monthly
- ☒ yearly or less frequently
- ☐ 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 known volume is added or removed (e.g., liquid, metal bar)
- ☒ theoretical ratio calculated from tank geometry
- ☐ 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
- ☐ value supplied by vendor of product
- ☒ average value for type of product
- ☐ other (describe briefly):

How is 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
- ☐ from data determined to be valid by statistical analysis
- ☒ other (describe briefly): From all data collected during the entire test.

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
- ☐ other (list):

Under what conditions are test results considered inconclusive?

- ☐ too much variability in the data (standard deviation beyond a given value)
- ☐ unexplained product volume increases
- ☒ other (describe briefly): Monitor determines validity of a test.

Exceptions

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

- ☐ water in the excavation zone
- ☐ large difference between ground temperature and delivered product temperature
- ☐ extremely high or low ambient temperature
- ☐ invalid for some products (specify):
- ☒ other (describe briefly): Act of God: Earthquake

What are acceptable deviations from the standard testing protocol?

- ☒ none
- ☐ lengthen the duration of test
- ☐ other (describe briefly):

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

- ☐ product level when test is conducted
- ☐ 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

Appendix D

Description, Volumetric Tank Tightness Testing Method

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

The Marley Pump Company Magnetostrictive Node for the Prolink System
Version RE-125-155

Product

> **Product type**

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

- ☒ gasoline
- ☒ diesel
- ☒ aviation fuel
- ☒ fuel oil #4
- ☒ fuel oil #6
- ☒ solvent
- ☒ waste oil
- ☒ other (list) Any liquid that is compatible with the probe and whose temperature characteristics can be determined.

> **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
- ☒ other (specify): from 15 inches of product to 95% full.

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

- ☐ yes
- ☒ no

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

- ☒ yes When used in conjunction with the Marley water sensor attached to the probe
- ☐ no

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

- ☒ yes When used in conjunction with the Marley water sensor attached to the probe
- ☐ 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
- ☒ changes 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
- ☒ 5 or more sensors
- ☐ temperature-averaging probe

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

- ☒ resistance temperature detector (RTD)
- ☐ bimetallic strip
- ☐ quartz crystal
- ☐ thermistor
- ☐ other (describe briefly)

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

- ☐ 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
- ☒ 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
- ☐ 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 a test? N/A

- ☐ no waiting period
- ☐ less than 1 hour
- ☐ 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
- ☐ variable

> **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)

6 hours 39 minutes (Assumes site has not received delivery for at least 12 hours. Dispensing may occur during this waiting time since last delivery.)

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

- ☒ 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 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):
- ☐ 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 increase by raising the level of the product
- ☐ different head pressures tested and leak rates compared
- ☒ method tests for changes in water level in tank
- ☐ other (describe briefly):
- ☐ 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
- ☒ 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
- ☒ 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 a 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
- ☒ no

If not, how often are the sensors calibrated?

- ☐ weekly
- ☐ monthly
- ☒ yearly or less frequently
- ☐ never

> **Interpreting test results**

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

- ☐ actual level changes observed when known volume is added or removed (e.g., liquid, metal bar)
- ☒ theoretical ratio calculated from tank geometry
- ☐ 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
- ☐ value supplied by vendor of product
- ☒ average value for type of product
- ☐ other (describe briefly):

How is 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
- ☐ from data determined valid by statistical analysis
- ☒ other (describe briefly): From all data collected during the entire test.

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
- ☐ other (list):

Under what conditions are test results considered inconclusive?

- ☐ ground-water level above bottom of tank
- ☐ presence of vapor pockets
- ☐ too much variability in the data (standard deviation beyond a given value)
- ☐ unexplained product volume increases
- ☒ other (describe briefly): Monitor determines validity of a test.

Exceptions

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

- ☐ ground-water level above bottom of tank
- ☐ presence of vapor pockets
- ☐ large difference between ground temperature and delivered product temperature
- ☐ high ambient temperature
- ☐ invalid for some products (specify):
- ☒ other (describe briefly): Act of God: Earthquake

What are acceptable deviations from the standard testing protocol?

- ☒ 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
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- ☐ determination that tank deformation has subsided
- ☐ determination of "outlier" data that may be discarded
- ☐ other (describe briefly):
- ☒ none