Evaluation of the Dri-sump Containment Tightness Testing Method

Final Report

Prepared for:

ACCENT Environmental

December 19, 2018

KWA

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Prepared for:
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523 FM 1819
Pollok, Texas 75969

December 19, 2018

Preface

This report describes the testing that was conducted on the Dri-sump Containment Tightness Test Method. The forms contained in this report are based on data collected using the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Non-volumetric Tank Tightness Methods", EPA/530/UST-90/005, March, 1990 and the pending revised protocol dated June 1, 2018. The testing was conducted by Ken Wilcox Associates, Inc. at the Fuels Management Research Center in Grain Valley, Missouri. This evaluation meets the requirements of the U.S. Environmental Protection Agency for Non-volumetric Tank Tightness Methods for Annual Tightness Testing on the containment sump portion of underground storage tanks.

The full evaluation report and certification forms are contained in Volume 1. The data sheets for the actual testing are contained in Volume 2. This report was prepared by Mr. Craig Wilcox, Ken Wilcox Associates, Inc. Technical questions regarding the Dri-sump Containment Tightness Test Method should be directed to Danny Brevard at 409-842-0150, info@dri-sump.com.

KEN WILCOX ASSOCIATES, INC.

Craig Wilcox

Craig D. Wilcox
President

December 19, 2018

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1.0 INTRODUCTION

The Environmental Protection Agency's (EPA's) regulations for underground storage tanks require owners and operators to check for leaks on a routine basis using one of a number of detection methods (40CFR Part 280, Subpart D). To ensure the effectiveness of these methods, the Environmental Protection Agency has set performance requirements for all leak detection equipment that is used to comply with the regulations. Leak detection systems which are used to conduct Annual Tightness Testing on underground storage tanks must be capable of detecting leaks of 0.1 gal/h with a Probability of Detection (P_D) of 95% and a Probability of a False Alarm (P_{FA}) of 5% or less. Additionally, the criteria stipulate that the procedure must be capable of detecting a leak from any portion of the tank system. It is up to tank owners and operators to select a method of leak detection that has been shown to meet the relevant performance standards.

To assist users of these test methods and equipment, the EPA has developed requirements for evaluating the performance of non-volumetric leak detectors. The Dri-sump Containment Tightness Test Method was evaluated using the EPA protocol "Standard Test Procedures for Evaluating Leak Detection Methods: Non-volumetric Tank Tightness Testing Methods", EPA/530/UST-90/005, March 1990 and the pending revised protocol dated June 1, 2018. This evaluation followed the guidelines in the standard protocol for the number of leaks as well as the induced leak rate.

This evaluation presents the results of 42 tests that were conducted using 3 large containment sumps that were installed using different types of backfill that are commonly used during sump installations. The type of backfill that was used for the 3 sumps were sand, native soil and pea gravel. The tests were conducted with the sump in a dry condition. This report describes the evaluation that was conducted on the Dri-sump Containment Tightness Testing Method. A common example of an appropriate application of this method is to tightness test the type of sump used to contain the connections made to the top of an underground storage tank (UST).

2.0 Description of the Dri-sump Containment Tightness Test Method

Equipment

Dri-sump Containment Tightness Testing method consists of the following equipment:

- Vapor/aerosol Dispenser
- Air Pressure Generator (to create high-volume-low-pressure (HVLP) negative or positive pressure
- Sealed View Chamber with test port and viewing ports
- Specialized Laser
- Misc. Hoses
- Vapor Aerosol Consumable
- Vapor Stimulator Tube (VST)

Scope

Dri-sump Containment Tightness Testing method can be used to test any complete containment sump including the sides, bottom and all penetration points to determine if the sump is liquid-tight. It is used to test the following:

- A method to test any open or closed top containment sump or tank, storage vessel, vault, or any other type containment located above and below ground.
- A method to test hazardous or non-hazardous containment sumps, vessels, tanks, vaults, etc. as listed including but not limited to under dispenser (UDC), submersible turbine pump (STP), transition, spill containment (spill bucket), and any other type containment sump or tank/vessel.
- A method capable of testing dry secondary containment for piping and tanks.
- A method to test the ullage portion of any tank or vessel.

Accent-Environmental suggests that the test method is 100% environmentally friendly since it uses no water, no chemicals that create any environmental hazard or impact and generates no harmful waste by-products.

Testing with heavy gases and/or vapor aerosols has been an industry standard in locating leaks in underground utility lines, clean rooms, aircraft fuselages, biological containment cabinetry and more. The Dri-sump Containment Tightness Test method was developed for the petroleum industry inspection and test requirements.

Dri-sump Containment Tightness Test method uses a heavy vapor aerosol instead of water to completely fill the sump, interstice or vessel. The test method requires filling the entire containment sump with heavy vapor aerosol which takes about 3-15 seconds, depending on the size of the sump. This vapor aerosol is made from a proprietary formula of chemicals which are all food grade, pH neutral, non-petroleum based, non-toxic, non-flammable, and pose no environmental impact. The dissipation of the aerosol reverts back to normal organic elements in ambient air.

The heavy vapor aerosol is simply introduced into the sump and then the air pressure generator "pulls" the soil gases from a small Vapor Stimulator Tube (VST) that is installed in the backfill adjacent to the sump directly into the viewing chamber. A laser is introduced into the viewing chamber. If a leak is detected, the tester will see a laser line or beam that looks like a "green laser beam". This beam is generated as it reflects on the micron particles of the vapor aerosol. If no leak is detected, the laser merely makes a "dot" (no vapor aerosol is present). The test is 60 seconds. The heavy vapor aerosol dissipates in about 5 to 10 minutes.

Location of Vapor Stimulator Tubes (VSTS)

The VST is a slotted tube made from PVC pipe. Slots are precision cut and placed at specific intervals in the PVC pipe to allow the flow of air or soil gas when negative or positive pressure is applied to the VST. The VST is installed in the backfill adjacent to the containment sump. Each VST consists of the precision slotted pipe with PVC seal-cap for the bottom and a tapered iron- pipe thread female fitting and male threaded seal-tight cap for the top which completely seals the VST when not in use. The following describes the number of VSTs, placement and depth for each type of containment sump.

VST Placement Chart

Containment Sump Type	Minimum Number of VSTS per Containment Sump	Maximum Horizontal Distance from Sump Wall	Minimum Length/Depth of VST from surface to bottom	PST Backfill Soil Type Acceptance*	Minimum Test Time for pass or fail results
Spill Bucket	1	8 inches (±1”)	18 inches	All	1 minute
Under Dispenser Containment Sump (UDC)	1	8 inches (±1”)	18 inches	All	1 minute
Transition Sump (UDC depth)	1	8 inches (±1”)	18 inches	All	1 minute
Transition Sump (STP depth)	2	8 inches (±1”)	36 inches	All	1 minute
Submersible Turbine Sump (STP)	2	8 inches (±1”)	36 inches	All	1 minute

*Backfill soils tested and evaluated by Ken Wilcox Associates, October 2, 2018: industry acceptable sand backfill, pea gravel backfill, native clay/silt backfill. See table 1 in for test times.

Additional Placement Criteria

VSTs can be installed as close as direct contact with any containment sump exterior wall to a maximum horizontal distance of 8 inches (±1”).

In the case of STP and deep Transition containment sumps, VSTs should be placed near the most penetration points at the prescribed minimum horizontal distance from the sump wall. The bottom of the VST should be within 12 inches vertically (above) the highest penetration point. The second VST should be placed near the opposite side, approximately 180 degrees from the opposing VST. VSTs, installed for these specific sumps are the same length.

VSTs can be installed in the soil between the exterior sump wall and interior man-way wall. This area is called the apron or gutter.

VSTs cannot be installed outside the backfilled soils or excavated area holding the containment sump and associated piping and equipment.

All sumps should be visually inspected for cracks and leak areas before beginning any test procedure including this test method. All visual cracks and leaks should be repaired, or the sump replaced before beginning any vacuum, pressure or hydrostatic test procedure.

Installation Summary Procedure for the VST

The VST requires advancing a small borehole in the backfill soils adjacent to the containment sump exterior wall. Inspect the interior of the containment sump to determine the location and penetration of all lines exiting the sump. Measure the depth from surface to the highest penetration point. In order to determine the best location to safely install the VST, please refer to the VST Placement Chart and the “Additional Placement Criteria section that is included in this report. The Certified Tester Training and Manual provide additional industry best practices information. A hole is installed at the VST placement location in the surface material using a portable hammer-drill or diamond-core drill. The hole is approximately 1 ½ inches in diameter. If necessary, a probe rod, or a tubular pipe that can be connected to portable air supply or potable water pressure can be used to make a small annular space in the backfill soils to the depth of the VST. The VST can be pushed, pressed or lightly hammered into this annular space. The top of the VST is sealed with a small section of backer-rod or similar material and then the area above the sealed section can be filled with hydraulic cement. The top of the VST is flush with the surrounding surface material and sealed with the hydraulic cement and tapered pipe thread fitting to eliminate any potential impact to the subsurface from a surface spill or leak. It takes approximately 5-10 minutes to install a VST.

Equipment Connection Pre-test

The View Chamber is checked to make sure the interior is clean, and seals are intact. All hose fittings are inspected to make sure the seals are in-place. Hoses are checked for blockages. The VST is checked for blockages. The Air Pressure Generator is checked to make sure the venturi is clear, and filters are clean. The Laser is inspected to insure it is working properly. The test equipment is connected by flexible hoses and quick-couple fittings for a closed and tight test system. The VST is connected to the top port on the View Chamber. The negative pressure side of the venturi is connected to the bottom port on the View Chamber. The Vapor/aerosol Dispenser is connected to the vapor discharge hose and turned on to warm up. The Air Pressure Generator is turned on and negative pressure should be observed by the deflection to the View Chamber exterior cabinet wall. The Vapor/aerosol Dispenser is checked to see that it is generating the vapor/aerosol into the sump. It takes 1-3 minutes to fill a 300-gallon STP sump and only seconds to completely fill a UDC, or Spill Bucket.

Test Procedure Summary

Since containment sumps for secondary containment are liquid-tight, they should contain only an insignificant amount of liquid that would not trigger a sensor alarm. After confirming the sump meets these criteria, the containment sump is filled completely with vapor aerosol. When the vapor aerosol exits the top of the sump and is sufficiently “hanging” thick in the interior of the sump, the test can begin. A smart phone or timer can be used to start the 1-minute test. The Air Pressure Generator is started by pressing the foot control switch and is operating the full test time. The laser is placed in one of the View Chamber’s viewing ports and should illuminate the interior of the View Chamber creating a “dot” on the bottom or lower side of the interior of the View Chamber. Either view port can be used to see the laser, or a smart phone or other visual aid can be used. If a “laser beam” appears in the View Chamber, the sump fails the leak test. If the “laser dot” stays a “dot”, then the sump passes the leak test. The test is completed at the end of one minute unless a laser beam appears before the end of the one-minute test. In this case, the sump fails the leak test. Re-testing requires disconnecting from the VST and removing the VST hose from any area that contains vapor aerosol. The Air Pressure Generator is switched on until the laser indicates the View Chamber and attached hoses are cleared of vapor aerosol. Re-testing can begin if necessary.

This method allows testing for any style containment sump for new installations, replacements, repairs or periodical tests.

3.0 Overview of the EPA Evaluation Procedures

The experimental procedure for evaluating this test method is based on the requirements described in the EPA protocol “Standard Test Procedures for Evaluating Leak Detection Methods: Non-volumetric Tank Tightness Testing Methods”, EPA/530/UST-005, March 1990. This method requires that a minimum of 42 tests be conducted, 21 under tight conditions and 21 with a leak rate at a fixed rate of 0.1 gal/h or less. In this case, the method was tested using 21 zero and 21 induced leaks generated using an orifice calibrated to a leak rate of 0.1 gal/h of unleaded fuel with a 4’ head of pressure. Leaks were produced inside the containment sump. Since temperature and filling cycles have no impact on this type of testing the matrix of tests includes only randomized zero and induced leaks. These results are provided in Table 1.

Leaks were induced using an orifice calibrated to 0.1 gal/h of unleaded fuel at 4’ of head pressure. The orifice was connected to the containment sump portion of the tank. The flow of the orifice was checked regularly to make sure that the flow was at the appropriate rate.

The leaks were induced by plugging the orifice into a quick connect fitting. Flow continued until the system declared a leak or a tight test. After each test, a new leak condition was established and a new test was started.

Testing was conducted in an actual full sized containment sump that was installed exactly as it would normally be at a fuel service station.

4.0 Test Results and Discussion

The official results of the testing are provided in Attachment A of this report on the EPA forms “Non-volumetric TTT Method - Results Forms.” The performance parameters of the method are summarized in Table 2 and the data and results are contained on the official EPA data reporting forms in Attachment A.

Calculation of P_D and P_{FA}

The equations used to calculate the Probability of a False Alarm (P_{FA}) and the Probability of Detection (P_D) were taken from the EPA Protocol for Non-volumetric methods. The P_{FA} is calculated from the equation

$$P_{FA} = TL_1/N_1$$

where TL_1 is the number of cases, where the method indicated a leak when no sample was present and N_1 is the total number of tests conducted. If no false alarms occur, the P_{FA} is zero or 0%. The upper level confidence interval for these results (UL) can be calculated using the equation

$$\text{UL for } P_{FA} = 1-(\alpha)^{(1/N_1)}$$

where N_1 is the number of tests performed with zero leaks and α is the confidence coefficient of 95%.

The corresponding P_D was calculated from the equation

$$P_D = TL_2/N_2$$

where TL_2 is the number of tests, where a leak was detected when product was present at the threshold level and N_2 is the number of tests conducted. The lower confidence limit (LL) for P_D is calculated from the equation

$$\text{LL for } P_D = \alpha^{1/N_2}$$

Where N_2 is the number of correct tests conducted with the induced leak.

A total of 42 tests were conducted for this evaluation of which 21 were leak tests and 21 were tight tests. There were no missed detection for the 21 leak tests and no false alarms for the 21 tight tests resulting in a P_D of a 0.1 gal/h leak of 100% and a P_{FA} on a tight tank of 0%. The 95% confidence interval is from 89.50% to 100% for the P_D and from 0% to 9.50% for the P_{FA}.

Average Data Collection Time

The test duration during the evaluation tests that were declared tight had an average time of 1 minute. The test duration where a leak was present varied based on the type of backfill that was present. The average detection time of a leak with backfill with sand was approximately 11 seconds. The average detection time of a leak with backfill with native soil was approximately 15 seconds. The average detection time of a leak with backfill with pea gravel was approximately 25 seconds. When there is vapor aerosol detected by the laser, a leak is declared immediately. During a test in a no leak condition, the test time was precisely 1 minute before a tight condition was declared. Once the presence or absence of a leak is established, additional sensitivity cannot be gained from longer monitoring times.

Temperature Factors and Stabilization Times

The Dri-sump Containment Tightness Test Method is not sensitive to temperature fluctuations. No temperature compensation or stabilization periods are required.

Table 1. Data Sheet Summarizing the Results – Dri-sump Containment Tightness Testing Method

Date: 10/2/2018

Run #	Start	End	Soil	Distance	Induced Leak	Reported Tight/Leak	Test Time (Sec)
1	1135	1135	Sand	18 inches	0.1	Leak	10
2	1156	1156	Sand	18 inches	0.1	Leak	12
3	1211	1212	Sand	18 inches	0	Tight	60
4	1215	1215	Sand	18 inches	0.1	Leak	12
5	1230	1231	Sand	18 inches	0	Tight	60
6	1231	1232	Sand	18 inches	0	Tight	60
7	1253	1253	Sand	18 inches	0.1	Leak	12
8	1257	1257	Sand	18 inches	0.1	Leak	10
9	1300	1300	Sand	18 inches	0.1	Leak	9
10	1303	1303	Sand	18 inches	0.1	Leak	9
11	1335	1336	Sand	18 inches	0	Tight	60
12	1342	1343	Sand	18 inches	0	Tight	60
13	1343	1344	Sand	18 inches	0	Tight	60
14	1345	1346	Sand	18 inches	0	Tight	60
15	1139	1140	Native Soil	12 inches	0	Tight	60
16	1144	1144	Native Soil	12 inches	0.1	Leak	14
17	1150	1150	Native Soil	12 inches	0.1	Leak	12
18	1205	1205	Native Soil	12 inches	0.1	Leak	15
19	1225	1226	Native Soil	12 inches	0	Tight	60
20	1227	1228	Native Soil	12 inches	0	Tight	60
21	1241	1242	Native Soil	12 inches	0	Tight	60
22	1255	1255	Native Soil	12 inches	0.1	Leak	18
23	1305	1305	Native Soil	12 inches	0.1	Leak	12
24	1308	1308	Native Soil	12 inches	0.1	Leak	20
25	1322	1322	Native Soil	12 inches	0.1	Leak	13
26	1337	1338	Native Soil	12 inches	0	Tight	60
27	1340	1341	Native Soil	12 inches	0	Tight	60
28	1346	1347	Native Soil	12 inches	0	Tight	60
29	1134	1134	Pea Gravel	24 inches	0.1	Leak	30
30	1153	1153	Pea Gravel	24 inches	0.1	Leak	22
31	1158	1158	Pea Gravel	24 inches	0.1	Leak	22
32	1220	1221	Pea Gravel	24 inches	0	Tight	60
33	1222	1223	Pea Gravel	24 inches	0	Tight	60
34	1223	1224	Pea Gravel	24 inches	0	Tight	60
35	1258	1258	Pea Gravel	24 inches	0.1	Leak	28
36	1306	1306	Pea Gravel	24 inches	0.1	Leak	28
37	1312	1313	Pea Gravel	24 inches	0	Tight	60
38	1317	1317	Pea Gravel	24 inches	0.1	Leak	24
39	1326	1327	Pea Gravel	24 inches	0	Tight	60
40	1329	1330	Pea Gravel	24 inches	0	Tight	60
41	1332	1333	Pea Gravel	24 inches	0	Tight	60
42	1334	1334	Pea Gravel	24 inches	0.1	Leak	24

5.0 CONCLUSIONS

The following conclusions are based on the testing described in this report.

1. The Dri-sump Containment Tightness Test Method meets the requirements of the US EPA for leak detection systems that are used for underground storage tank containment sumps.

2. This technology is capable of detecting leaks equivalent to a 0.1 gal/h leak with a probability of 100%. The 95% confidence interval for P_D is from 89.50% to 100%.

3. The technology will work in any type of backfill, including sand, native soil and pea gravel, that is typically used during a containment sump, UDC or spill bucket installation.

4. The false alarm rate was determined to be 0%. The confidence interval for P_{FA} is from 0 to 9.50%.

Appendix A

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

Results of U.S. EPA Standard Evaluation

Non-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: Non-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 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 Dri-sump Containment Tightness Testing Method

Version Dri-sump Containment Tightness Testing Method

Vendor ACCENT Environmental

523 FM 1819
(street address)

Pollok	Texas	USA	75969	(409) 842-0150
(city)	(state)	(country)	(zip)	(phone)

Evaluation Results

This method, which declares a tank to be leaking when A solid laser beam of light is visible which is created when a "light sheet" of the vapor aerosol micron-size particles are presented in the laser as it is introduced into the view chamber

has an estimated probability of false alarms [P(FA)] of 0 %based on the test results of 0 false alarms out of 21 tests with no leak present. A 95% confidence interval for P(FA) is from 0 to 9.50 %.

The corresponding probability of detection [P(D)] of a 0.1 gallon per hour leak is 100 % based on the test results of 21 detections out of 21 simulated leak tests. A 95% confidence interval for P(D) is from 89.50 to 100 %.

Does this method use additional modes of leak detection? ☐Yes X No. If Yes, complete additional evaluation results on page 3 of this form.

Based on the results above, and on page 3 if applicable, 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 three different Containment Sumps that were 300 -gallon **X** steel __ fiberglass tank that was 30 inches in diameter and 60 inches long, installed in as would typically be found at a fuel service station. The 3 sumps were installed in different backfill types including sand, pea gravel and native soil.

The ground-water level was NA inches above the bottom of the tank.

Non-volumetric TTT Method Dri-sump Containment Tightness Test Method
Version Dri-sump Containment Tightness Test Method

Test Conditions During Evaluation (continued)

The tests were conducted with the tank between NA and NA full.

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

The product used in the evaluation was Air .

This method may be affected by other sources of interference. List these interferences below and give the ranges of conditions under which the evaluation was done. (Check None if not applicable.)

X None

Interferences	Range of Test Conditions

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 contains a product identified on the method description form.
- The tank capacity is NA gallons or smaller.
- The difference between added and in-tank product temperatures is no greater than + or – NA degrees Fahrenheit.

X Check if applicable:

Temperature is not a factor because The system uses a laser that detects a vapor aerosol solution that is unaffected by temperature variations.

- The waiting time between the end of filling the test tank and the start of the test data collection is at least 0 hours.
- The waiting time between the end of "topping off" to final testing level and the start of the test data collection is at least 0 hours.
- The total data collection time for the test is at least 10 seconds.
- The product volume in the tank during testing is between NA
- This 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:

Non-volumetric TTT Method_____Dri-sump Containment Tightness Testing Method__________
Version_____Dri-sump Containment Tightness Testing Method_______________

> **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.**

Additional Evaluation Results (if applicable)

This method, which declares a tank to be leaking when A solid laser beam of light is visible which is created when a "light sheet" of the vapor aerosol micron-size particles are presented in the laser as it is introduced into the view chamber

has an estimated probability of false alarms [P(FA)] of 0 % based on the test results of 0 false alarms out of 21 tests with no leak present. **Note**: A perfect score during testing does not mean that the method is perfect. Based on the observed results, a 95% confidence interval for P(FA) is from 0 to 9.50 %.

The corresponding probability of detection [P(D)] of a 0.1 gallon per hour leak is 100 % based on the test results of 21 detections out of 21 simulated leak tests. **Note**: A perfect score during testing does not mean that the method is perfect. Based on the observed results, a 95% confidence interval for P(D) is from 89.50% to 100 %.

> **Water detection mode (if applicable)**

Using a false alarm rate of 5%, the *minimum water level* that the water sensor can detect with a 95% probability of detection is NA inches.

Using a false alarm rate of 5%, the *minimum change in water level* that the water sensor can detect with a 95% probability of detection is NA inches.

Based on the minimum water level and change in water level that the water sensor can detect with a false alarm rate of 5% and a 95% probability of detection, the *minimum time* for the system to detect an increase in water level at an incursion rate of 0.10 gallon per hour is NA minutes in a - gallon tank.

Certification of Results

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

Craig Wilcox	Ken Wilcox Associates
(printed name)	(organization performing evaluation)
Craig Wilcox	Grain Valley, MO
(signature)	(city, state, zip)
December 19, 2018	816-443-2494
(date)	(phone number)

Description
Nonvolumetric Tank Tightness Testing Method

This section describes briefly the important aspects of the nonvolumetric 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

Dri-sump Containment Tightness Test method

Product

> Product type

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

- ☐ gasoline
- ☐ diesel
- ☐ aviation fuel
- ☐ fuel oil #4
- ☐ fuel oil #6
- ☐ solvents
- ☐ waste oil
- ☐ other (list) NA

> Product level

What product level is required to conduct a test?

- ☐ above grade
- ☐ within the fill pipe
- ☐ greater than 90% full
- ☐ greater than 50% full
- ☐ empty
- ☐ other (specify) NA

Principle of Operation

What principle or principles are used to identify a leak?

☐ acoustical signal characteristic of a leak
☐ identification of a tracer chemical outside the tank system
☐ changes in product level or volume
☐ detection of water inflow
☒ other (describe briefly) identification of laser reaction to vapor aerosol chemical outside or inside the tank system

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) NA

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

☐ the factor measured for change in level or volume is independent of temperature (e.g., mass)
☐ the factor measured for change in level or volume self-compensates for changes in temperature
☐ other (explain briefly) NA

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)?

- ☒ not applicable
- ☐ 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

>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)

___________hours 1 minutes

>Other important elements of the procedure or method

List here any other elements that could affect the performance of the procedure or method (e.g., positive or negative ullage pressure, tracer concentration, distance between tank and sampling ports, etc.)

>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)______________NA_________________________________
- ☐ 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
- ☐ tests for changes in water level in tank
- ☐ other (describe briefly)________NA_______________________________________
- ☐ no action

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

- ☐ yes NA
- ☐ no

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

- ☐ yes NA
- ☐ no

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)________NA_______________________________________
- ☐ 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) NA
☐ 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 test
☐ watch the data trends and begin test when decrease in product level has stopped
☐ other (describe briefly) NA
☐ no procedure
☐ not applicable, does not affect principle of operation

Are the method's sensors calibrated before each test? NA

☐ yes
☐ no

If not, how often are the sensors calibrated? NA

☐ weekly
☐ monthly
☐ yearly or less frequently
☐ never

>Interpreting test results

What effect is used to declare the tank to be leaking? (List all modes used by the method.)

Visual identification of leak, hole, crack, improper fitting fails test unless verified as repaired on side of vessel that is not visible

A solid laser beam of light is visible which is created when a "light sheet" of the vapor aerosol micron-size particles are presented in the laser as it is introduced into the view chamber

If a change in volume is used to detect leaks, 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 NA

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 increase
☐ other (describe briefly)________NA______________________________________

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
☐ extremely high or low ambient temperature
☐ invalid for some products (specify) ______________________________________
☐ soil not sufficiently porous
☐ other (describe briefly)________NA______________________________________

What are acceptable deviations from the standard testing protocol?

☐ none
☐ lengthen the duration of test
☐ other (describe briefly)________NA______________________________________

What elements of the test procedure are left to the discretion of the 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)________NA______________________________________
☐ none

Appendix B

Results Form for the
Dri-sump Containment Tightness Testing Method

Date: 10/2/2018

Run #	Start	End	Soil	Distance	Induced Leak	Reported Tight/Leak	Test Time (Sec)
1	1135	1135	Sand	18 inches	0.1	Leak	10
2	1156	1156	Sand	18 inches	0.1	Leak	12
3	1211	1212	Sand	18 inches	0	Tight	60
4	1215	1215	Sand	18 inches	0.1	Leak	12
5	1230	1231	Sand	18 inches	0	Tight	60
6	1231	1232	Sand	18 inches	0	Tight	60
7	1253	1253	Sand	18 inches	0.1	Leak	12
8	1257	1257	Sand	18 inches	0.1	Leak	10
9	1300	1300	Sand	18 inches	0.1	Leak	9
10	1303	1303	Sand	18 inches	0.1	Leak	9
11	1335	1336	Sand	18 inches	0	Tight	60
12	1342	1343	Sand	18 inches	0	Tight	60
13	1343	1344	Sand	18 inches	0	Tight	60
14	1345	1346	Sand	18 inches	0	Tight	60
15	1139	1140	Native Soil	12 inches	0	Tight	60
16	1144	1144	Native Soil	12 inches	0.1	Leak	14
17	1150	1150	Native Soil	12 inches	0.1	Leak	12
18	1205	1205	Native Soil	12 inches	0.1	Leak	15
19	1225	1226	Native Soil	12 inches	0	Tight	60
20	1227	1228	Native Soil	12 inches	0	Tight	60
21	1241	1242	Native Soil	12 inches	0	Tight	60
22	1255	1255	Native Soil	12 inches	0.1	Leak	18
23	1305	1305	Native Soil	12 inches	0.1	Leak	12
24	1308	1308	Native Soil	12 inches	0.1	Leak	20
25	1322	1322	Native Soil	12 inches	0.1	Leak	13
26	1337	1338	Native Soil	12 inches	0	Tight	60
27	1340	1341	Native Soil	12 inches	0	Tight	60
28	1346	1347	Native Soil	12 inches	0	Tight	60
29	1134	1134	Pea Gravel	24 inches	0.1	Leak	30
30	1153	1153	Pea Gravel	24 inches	0.1	Leak	22
31	1158	1158	Pea Gravel	24 inches	0.1	Leak	22
32	1220	1221	Pea Gravel	24 inches	0	Tight	60
33	1222	1223	Pea Gravel	24 inches	0	Tight	60
34	1223	1224	Pea Gravel	24 inches	0	Tight	60
35	1258	1258	Pea Gravel	24 inches	0.1	Leak	28
36	1306	1306	Pea Gravel	24 inches	0.1	Leak	28
37	1312	1313	Pea Gravel	24 inches	0	Tight	60
38	1317	1317	Pea Gravel	24 inches	0.1	Leak	24
39	1326	1327	Pea Gravel	24 inches	0	Tight	60
40	1329	1330	Pea Gravel	24 inches	0	Tight	60
41	1332	1333	Pea Gravel	24 inches	0	Tight	60
42	1334	1334	Pea Gravel	24 inches	0.1	Leak	24