Executive Order VR-209-A
VST Phase II EVR System with Clean Air Separator

Exhibit 5
Liquid Removal Test Procedure

Definitions common to all certification and test procedures are in:

D-200 Definitions for Vapor Recovery Procedures

For the purpose of this procedure, the term "ARB" refers to the California Air Resources Board, and the term "Executive Officer" refers to the ARB Executive Officer or his or her authorized representative or designate.

1. PURPOSE AND APPLICABILITY

1.1 This procedure is used to quantify the removal rate of liquid from the vapor passage of a Phase II balance system hose equipped with a liquid removal device. This procedure provides a method to determine compliance with the liquid removal requirements specified in ARB Executive Orders VR-203 and VR-204 and any subsequent amendments or revisions.

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

2.1 This test procedure provides two options to determine the compliance of liquid removal devices. Under option 1 (short version), liquid in the vapor path of a coaxial hose is drained and measured. If the volume of liquid drained equals or exceeds 25 ml, a liquid removal test is conducted. For those hoses with less than 25 ml drained, no further testing is required. Under option 2 (long version), all hoses are evaluated regardless of the volume of liquid drained. Option 2 includes a prewetting and wall adhesion step. Both options test the liquid removal device by introducing gasoline into the vapor path of the coaxial hose through the nozzle bellows. After 7.5 gallons of gasoline is dispensed, the amount of gasoline remaining in the hose is measured and the liquid removal rate is determined. The district shall specify which testing option is to be used.

Caution: When draining liquid from the vapor side of the hose, make sure the dispenser is not activated. The nozzle vapor valve is on the same stem as the fuel valve. To drain gasoline from the vapor side of the hose, the fuel lever must be engaged. If the dispenser is activated, gasoline in the fuel hose may be pressurized when engaging the fuel lever.

3. BIASES AND INTERFERENCES

3.1. Slits or tears in the hose or nozzle vapor path may bias the results towards compliance.

3.2. This test shall not be conducted on any fueling point where the hanging hardware is defective as identified in Exhibit 2.

3.3. Any spillage of gasoline invalidates the test for any volumes that are required to be measured or recorded.

3.4. A breach of the inner product hose may introduce additional gasoline into the outer vapor path resulting in a larger volume drained than introduced.

3.5. Not having the liquid extraction device (indicated by the mark on the outside of the house) at the bottom of the hose loop during liquid removal testing, as shown in Figure 1, will bias the results towards failure.

3.6. The test procedure requires the use of VST's nozzle spout plug, P/N VST-STP-100 as shown in Figure 2. This tool is used to plug the spout when draining liquid from the vapor side of the hose. Not plugging the spout may bias the results towards failure. Nicks, cuts, or tears in the plug o-rings will bias the results towards failure.

3.7. Dispensing rates not between 6.0 and 10.0 gallons per minute (GPM) invalidates the test.

4. SENSITIVITY, RANGE, AND PRECISION

4.1 The range of measurement of the liquid removal rate is dependent upon the range of the graduated cylinder used for testing.

4.2 To ensure precision, graduated cylinder readings shall be measured at the liquid level meniscus.

5. EQUIPMENT

5.1. Nozzle Spout Plug: Use VST's spout plug, P/N VST-STP-100 (Figure 2).

5.2. Stopwatch. Use a stopwatch accurate to within 0.2 seconds.

5.3. Funnels. Large and small gasoline compatible, non-breakable, funnels with dimensions similar to those as shown in Figure 3, or equivalent.

5.4. Graduated Cylinders. Gasoline compatible, non-breakable 0-25ml, 0-100ml, 0-250 ml, and 0-500 ml graduated cylinders with stable base plates. The 25ml cylinder may be necessary to quantify volumes of liquid less than 20 ml.

5.5. Gasoline Test Tank. (Optional) A portable tank, meeting fire safety requirements for use with gasoline, may be used to receive the gasoline dispensed during testing. The tank shall have sufficient volume so that at least 10.0 gallons may be dispensed prior to activating the primary shutoff mechanism of the nozzle. **When using a gasoline test tank, ensure that a ground strap is used and that it is properly connected to an acceptable ground.** To minimize testing-related emissions, vehicle refueling events should be used for this procedure whenever feasible.

5.6. Traffic Cones. Use traffic cones to encircle the area where testing is conducted.

5.7. Field Data Sheet. Use the appropriate data sheet to record liquid removal test information. Forms 1 and 2 serve as examples; districts may require modified versions.

5.8. Gasoline Container. Use a portable fuel container equipped with a tight fitting cap, of at least 1.0 gallon capacity.

NOTE: THIS TEST PROCEDURE PROVIDES TWO OPTIONS TO DETERMINE COMPLIANCE OF LIQUID REMOVAL DEVICES. THE DISTRICT SHALL SPECIFY WHICH TESTING OPTION IS TO BE USED

6. OPTION 1 (SHORT VERSION)

PRE-TEST PROCEDURE

6.1 Verify that the 500 ml graduated cylinder is empty. Position the large funnel into the graduated cylinder.

6.2 Remove the nozzle from the dispenser. **Do not activate dispenser!** Install VST's spout plug, P/N VST-STP-100 in the tip of the spout (Figure 2). Carefully tilt the spout into the funnel/graduated cylinder assembly.

6.3 Lower the nozzle and funnel/graduated cylinder assembly as close to the ground as possible. "Walk out" the hose while keeping the nozzle lowered and hose fully extended. The hose shall slope downward from the dispenser toward the nozzle.

6.4 **Do not activate dispenser!** Open the nozzle's vapor check valve by compressing the bellows and engaging the fuel lever. Allow 20 seconds for all liquid to drain. Use caution to avoid spillage.

6.5 Remove VST's spout plug and return the nozzle to the dispenser and measure the volume of liquid drained. If the volume drained is less than 200 ml, transfer the liquid into an appropriately sized graduated cylinder. For example, if 40 ml of liquid was drained, use the 100 ml graduated cylinder to take the measurement.

6.6 Record the amount of liquid drained on Form 1 ("PRE-TEST").

6.7 If the volume drained is greater than or equal to 25 ml, proceed to Section 6.8 of the procedure. Hoses with greater than 25 ml drained are considered to be pre-wetted. If the amount drained is less than 25 ml, proceed to the next nozzle/hose to be evaluated and repeat Section 6.1-6.6

TEST PROCEDURE (FOR HOSES WITH GREATER THAN 25 ML DRAINED)

6.8 Pour 150 ml to 175 ml of gasoline into the 250 ml graduated cylinder. Measure and record this volume on Form 1 (VI).

6.9 Remove the nozzle from the dispenser and position the nozzle upright so that the

spout is in a vertical position. **Do not activate dispenser!**

6.10 Open the nozzle's vapor check valve by compressing the bellows and engaging the fuel lever. Carefully insert the stem of the small funnel between the bellows and nozzle spout.

6.11 Pour the measured volume into the vapor path of the hose. Use caution not to spill the gasoline. Remove the small funnel after the gasoline has been introduced.

6.12 Insert the nozzle into a vehicle or test tank fill pipe.

6.13 Find the mark on the outside of the hose which indicates the location of the liquid pick-up device. Ensure the mark is at the bottom of the hose loop when dispensing as shown in Figure 1. This can be accomplished by lifting up the back of the hose, adjusting nozzle position, or adjusting the test tank position.

6.14 Dispense 7.5 (±0.5) gallons at the highest possible flow rate by holding the nozzle lever in the maximum handheld position. Use a stopwatch to measure the time elapsed while dispensing. Record the volume of fuel dispensed (G) and the elapsed time (T) on Form 1. Return nozzle to the dispenser.

6.15 Calculate the dispensing rate using the equation below. If the dispensing rate is not between 6.0 and 10.0 gallons per minute (GPM), the test results are invalid.

$$GPM = 60 \times \left(\frac{G}{T} \right)$$

Where:

GPM	=	dispensing rate (in gallons per minute)
G	=	gallons of fuel dispensed
T	=	number of seconds required to dispense

6.16 Using the 250 ml graduated cylinder and large funnel, carefully drain the remaining liquid from the vapor path of the hose as described in Section 6.1 through 6.5 **(make sure dispenser is not activated and spout plug is installed before draining liquid!)**. Record this quantity on Form 1 (VF).

6.17 Use Equation 9.1 to calculate the liquid removal rate for all the applicable hoses tested.

6.18 If the liquid removal rate is less than 5.0 ml/gallon, but greater than or equal to 4.5 ml/gallon, repeat the test two additional times and average the three results.

7. OPTION 2 (LONG VERSION)

PRETEST PROCEDURE

7.1 Carefully pour 150 ml of gasoline into the 250 ml graduated cylinder.

7.2 Remove the nozzle from the dispenser. **Do not activate dispenser!** Install VST's spout plug, P/N VST-STP-100 in the tip of the spout as shown in Figure 2. Position the nozzle upright so that the spout is in a vertical position.

7.3 Open the nozzle's vapor check valve by compressing the bellows and engaging the fuel lever. Carefully insert the stem of the small funnel between the bellows and nozzle spout.

7.4 Pour the gasoline from the 250 ml graduated cylinder into the vapor path of the hose. Use caution not to spill the gasoline. Remove the small funnel after the gasoline has been introduced.

7.5 Verify that the 500 ml graduated cylinder is empty. Position the large funnel into the graduated cylinder.

7.6 Carefully tilt the spout into the funnel/graduated cylinder assembly. **Make sure VST's spout plug is installed and the dispenser is deactivated.**

7.7 Lower the nozzle and funnel/graduated cylinder assembly as close to the ground as possible. "Walk out" the hose while keeping the nozzle lowered and hose fully extended. The hose shall slope downward from the dispenser toward the nozzle.

7.8 Open the nozzle's vapor check valve by compressing the bellows and engaging the fuel lever. Allow 20 seconds for all liquid to drain. Use caution to avoid spillage. If necessary, drain full graduated cylinders into a portable gas can until the hose is empty.

7.9 Remove VST's spout plug and return the nozzle to the dispenser.

TEST PROCEDURE

7.10 Pour 150 ml to 175 ml of gasoline into the 250 ml graduated cylinder. Measure and record this volume on Form 2 (VI).

7.11 Remove the nozzle from the dispenser. **Do not activate dispenser!** Position the nozzle upright so that the spout is in a vertical position.

7.12 Open the nozzle's vapor check valve by compressing the bellows and engaging the fuel lever. Carefully insert the stem of the small funnel between the bellows and nozzle spout.

7.13 Pour the measured volume into the vapor path of the hose. Use caution not to spill the gasoline. Remove the small funnel after the gasoline has been introduced.

7.14 Insert the nozzle into a vehicle or test tank fill pipe.

7.15 Find the mark on the outside of the hose which indicates the location of the liquid pick-up device. Ensure the mark is at the bottom of the hose loop when dispensing

as shown in Figure 1. This can be accomplished by lifting up the back of the hose, adjusting nozzle position, or adjusting the test tank position.

7.16 Dispense 7.5 (±0.5) gallons at the highest possible flow rate by holding the nozzle lever in the maximum handheld position. Use a stopwatch to measure the time elapsed while dispensing. Record the volume of fuel dispensed (G) and the elapsed time (T) on Form 2. Return nozzle to the dispenser.

7.17 Calculate the dispensing rate using the equation below. If the dispensing rate is not between 6.0 and 10.0 gallons per minute (GPM), the test results are invalid.

$$GPM = 60 \times \left(\frac{G}{T} \right)$$

Where:

GPM	=	dispensing rate (in gallons per minute)
G	=	gallons of fuel dispensed
T	=	number of seconds required to dispense

7.18 Using the 250 ml graduated cylinder and large funnel, carefully drain the remaining liquid from the vapor path of the hose as described in Section 7.5 through 7.8 **(make sure dispenser is deactivated and spout plug is installed before draining liquid!)**. Record this quantity on Form 2 (VF).

7.19 Open the nozzle's vapor check valve by compressing the bellows and engaging the fuel lever. **Do not activate dispenser!** Carefully insert the stem of the small funnel between the bellows and nozzle spout

7.20 Use the 250 ml graduated cylinder and small funnel to pour 150 ml of gasoline into the vapor passage of the hose. Dispense no gasoline.

7.21 Using the 250 ml graduated cylinder and large funnel, completely drain the gasoline from the vapor passage back into the graduated cylinder as described in Section 7.5 through 7.9 **(make sure dispenser is deactivated and spout plug is installed before draining liquid!)**.

7.22 Subtract the volume drained (value from Section 7.21) from the volume added (value from Section 7.20). This value represents the volume of gasoline lost due to wall adhesion. The purpose of the wall adhesion value is to quantify the amount of gasoline lost to evaporation from transfer to and from the graduated cylinders and adhesion of liquid to vapor passage surfaces in previous measurements. Record this quantity on Form 2 (VW).

7.23 Use Equation 9.2 to calculate the liquid removal rate for all the applicable hoses tested.

7.24 If the liquid removal rate is less than 5.0 ml/gallon, but greater than or equal to 4.5 ml/gallon, repeat the test two additional times and average the three results.

8. POST TEST PROCEDURES

8.1. Empty all containers and return any excess gasoline to the underground storage tank.

8.2. Remove the traffic cones from the testing area.

9. CALCULATING RESULTS

9.1 If using OPTION 1(short version), the liquid removal rate shall be calculated as follows:

$$VR = \frac{VI - VF}{G}$$

Where:

VR	=	Gasoline removed per gallon dispensed, milliliters/gallon
VI	=	Total initial volume poured into hose vapor passage, milliliters
VF	=	Volume of gasoline remaining in the hose vapor passage after dispensing, milliliters
G	=	Total dispensed, gallons

9.2 If using OPTION 2 (long version), the liquid removal rate shall be calculated as follows:

$$VR = \frac{(VI - VW) - VF}{G}$$

Where:

VR	=	Gasoline removed per gallon dispensed, milliliters/gallon
VI	=	Total initial volume poured into hose vapor passage, milliliters
VW	=	Volume of liquid lost due to wall adhesion, milliliters
VF	=	Volume of gasoline remaining in the hose vapor passage after dispensing, milliliters
G	=	Total dispensed, gallons

10. REPORTING RESULTS

10.1. Record all applicable liquid removal rate information on the appropriate form as shown in Form 1 and 2. Districts may require the use of alternate forms provided that the alternate forms include the same parameters as identified in Forms 1 and 2.

10.2. If the calculated liquid removal rate is greater than or equal to 5 milliliters/gallon, the liquid removal device has demonstrated compliance.

10.3. If the calculated liquid removal rate is less than 5 milliliters/gallon, the liquid removal device is not in compliance.

11. ALTERNATIVE TEST PROCEDURES

This procedure shall be conducted as specified. Modifications to this test procedure shall not be used to determine compliance unless prior written approval has been obtained from the Executive Officer, pursuant to Section 14 of Certification Procedure CP-201.

FIGURE 1
Position of Liquid Removal Device
When Conducting Liquid Removal Testing

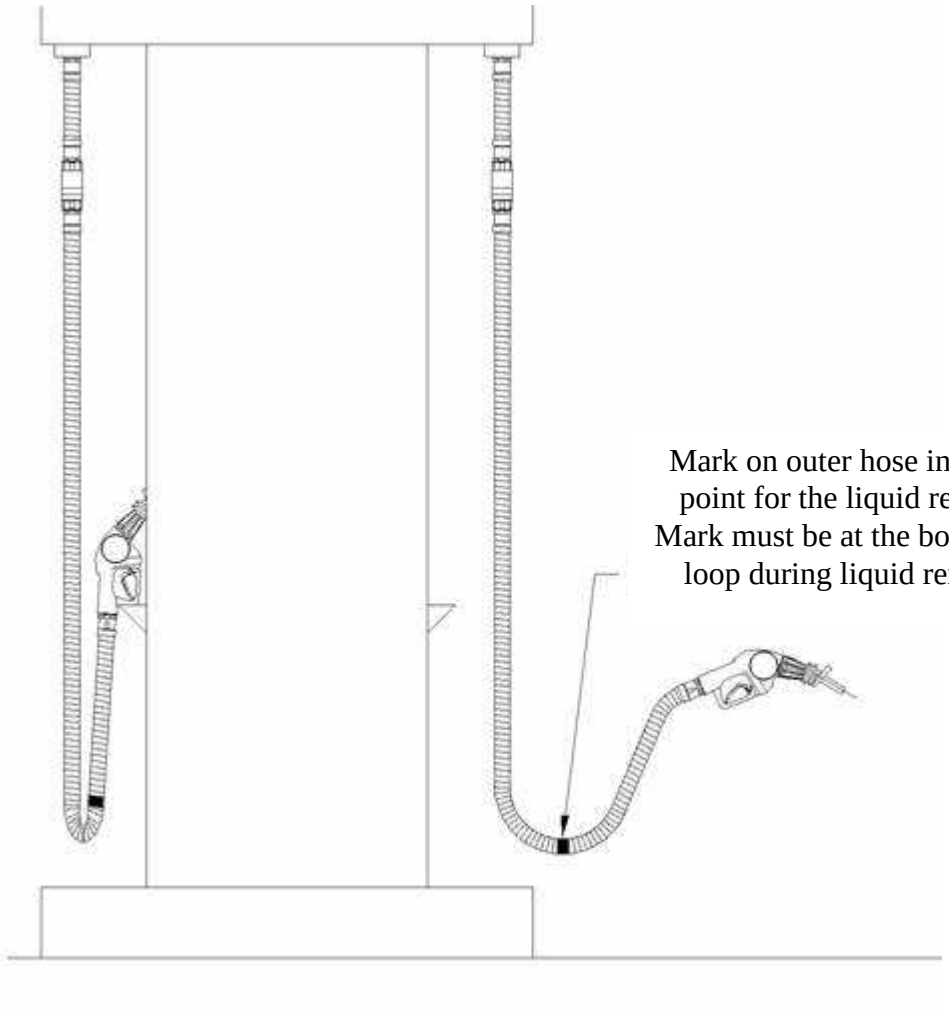
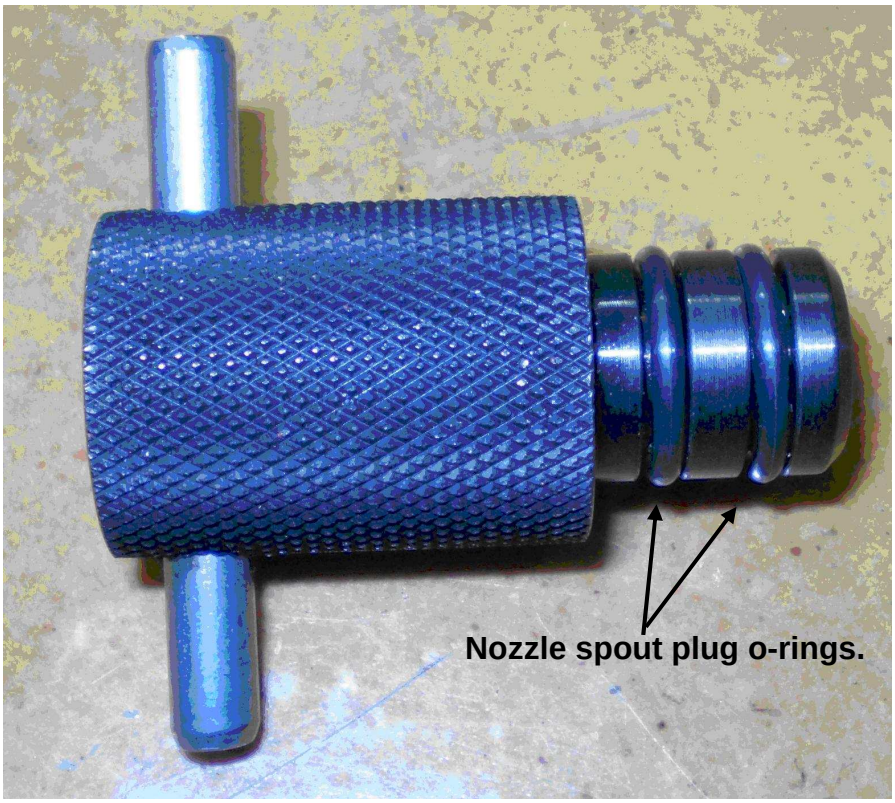
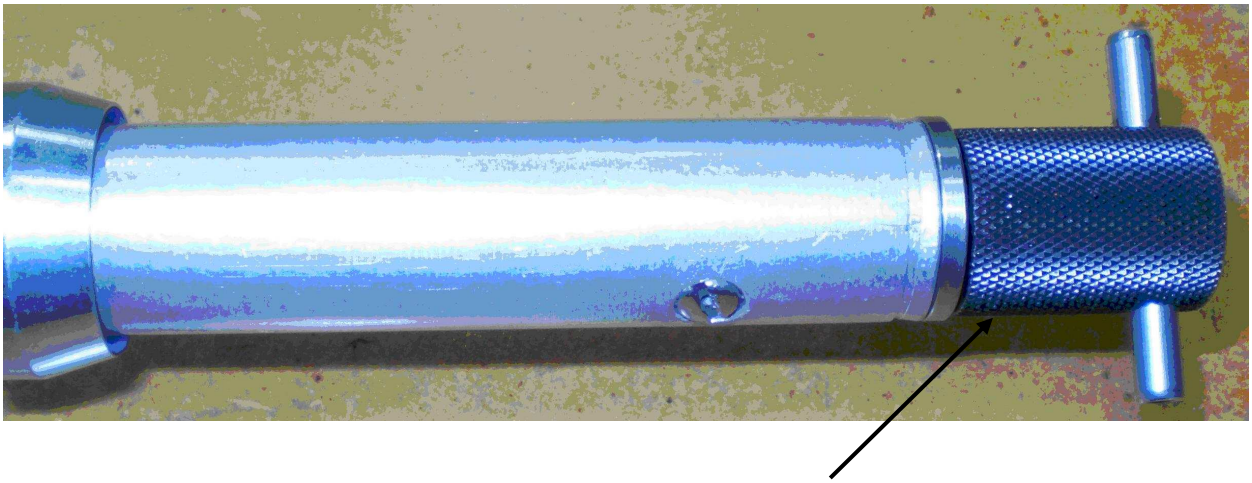


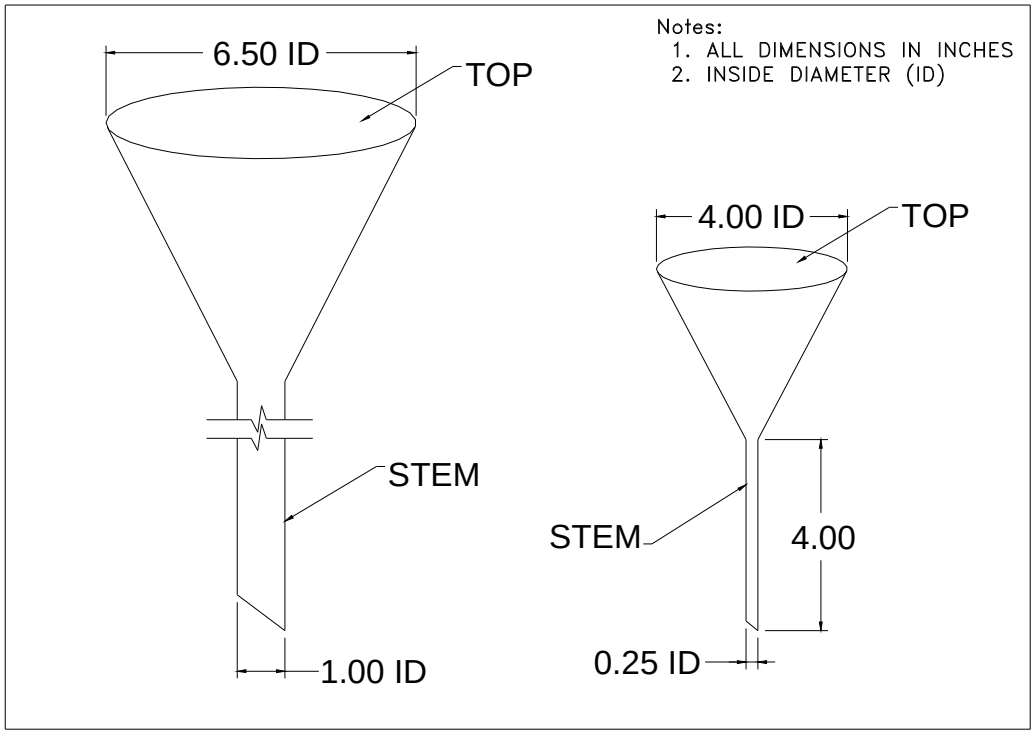
FIGURE 2
VST Nozzle Spout Plug P/N VST-STP-100





Plug properly inserted into nozzle spout.
Both plug o-rings seated into nozzle spout.

FIGURE 3
Recommended FUNNEL SPECIFICATIONS



FORM 1: LIQUID REMOVAL TEST DATA SHEET (OPTION 1)

Facility Name & Address	Facility Representative & Title
	Phone No.

Test Date _____
A/C or Permit No. _____
Testing Company _____
Tester Name _____
VST Training Cert # (if applicable) _____
Inspector Name _____

GENERAL INFORMATION				PRE-TEST	TEST RUN					VR=(VI-VF)/G
Dispenser Number	Product Grade	Make & Model of Hose	Serial Number of Hose	Volume Drained From Hose in mL	Volume Poured Into Hose in mL (VI)	Gallons Dispensed (G)	Seconds to Dispense (T)	Dispensing Rate (60*(G/T))	Volume Remaining in mL (VF)	Liquid Removal Rate (mL/gal)

FORM 2: LIQUID REMOVAL TEST DATA SHEET (OPTION 2)

Facility Name & Address	Facility Representative & Title
	Phone No.

Test Date _____
A/C or Permit No. _____
Testing Company _____
Tester Name _____
VST Training Cert # (if applicable) _____
Inspector Name _____

GENERAL INFORMATION				PRE-TEST	TEST RUN					VR=((VI-VW)-VF)/G
Dispenser Number	Product Grade	Make & Model of Hose	Serial Number of Hose	Volume Poured into Hose in mL (VI)	Gallons Dispensed (G)	Seconds to Dispense (T)	Dispensing Rate (60*(G/T))	Volume Remaining in mL (VF)	Volume Lost to Wall Adhension in mL (VW)	Liquid Removal Rate (mL/gal)