-STATIC LEAK TEST
(taken from BAAQMD test procedure ST-30)

l. Applicability

1.1 This test procedure is used to quantify the vapor tightness of vapor control systems installed at any gasoline dispensing facility (GDF) equipped with pressure/vacuum (P/V) valves, provided that the designed pressure setting of the P/V valves is a minimum of 2.5 inches of water column (inches H_2O). Excessive leaks in the vapor control system will increase the quantity of fugitive hydrocarbon emissions and lower the overall efficiencies of both the Stage I and Stage II vapor control systems.

1.2 For those systems equipped with a P/V valve allowed to have a designed cracking pressure less than 2.5 inches H_2O, the valve shall be bagged to eliminate, from the test results, any flow contribution through the valve assembly. The valve/vent pipe connection, however, shall remain unobstructed during this test.

1.3 For those facilities not required to be equipped with a P/V valve, the vent pipe shall be capped. For these installations, the test may be conducted at the vent pipe.

2. Principle

2.1 The entire vapor control system is pressurized with nitrogen to two (2.0) inches H_2O. The system pressure is then allowed to decay and the pressure after five (5) minutes is compared with an allowable value. The minimum allowable five-minute final pressure is based on the system ullage and pressure decay equations. For the purpose of compliance determination, this test shall be conducted after all back-filling, paving, and installation of all Stage I and Stage II components, including P/V valves, has been completed.

2.2 For a GDF equipped with a coaxial Stage I system this test shall be conducted at a Stage II vapor riser. For a GDF which utilizes a two-point Stage I system this test shall be conducted at the Stage I vapor coupler, provided that the criteria set forth in Section 6.7 have been met. If the integrity criteria for two-point systems specified in Section 6.7 are met, this test shall be conducted at the Stage I vapor coupler unless the vapor control system possesses a design which is incompatible with testing at this location.

3. Range

3.1 If mechanical pressure gauges are employed, the full-scale range of the pressure gauges shall be 0-2.0, 0-1.0, and 0-0.50 inches H_2O column. Maximum incremental graduations of the pressure gauge shall be 0.05 inches H_2O and the minimum accuracy of the gauge shall be three percent of full scale. The minimum diameter of the pressure gauge face shall be 4 inches.

3.2 If an electronic pressure measuring device is used, the full-scale range of the device shall not exceed 0-10 inches H_2O with a minimum accuracy of 0.5 percent of full-scale. A 0-20 inches H_2O device may be used, provided the equivalent accuracy is not less than 0.25 percent of full scale.

3.3 The minimum ullage during the test shall be 25 percent of the tank capacity (total of **all** tanks if manifolded) or 500 gallons, whichever is greater. The maximum total ullage shall be 25,000 gallons. These values are exclusive of all vapor piping volumes.

3.4 The minimum and maximum nitrogen feed-rates, into the system, shall be one (1) and five (5) CFM, respectively.

4. Interferences

4.1 Nitrogen shall not be introduced into the system at flowrates exceeding five (5) CFM as this may bias the results of the test toward non-compliance.

4.2 For vacuum-assist Stage II systems which utilize an incinerator, power to the collection unit shall be turned off during testing.

4.3 For vacuum-assist systems which locate the vacuum producing device in-line, between the Stage II vapor riser and the storage tank, the following shall apply:

4.3.1 A valve shall be installed at the vacuum producing device. When closed, this valve shall isolate the vapor passage downstream of the vacuum producing device.

4.3.2 The storage tank side of the vacuum producing device shall be tested in accordance with the procedures outlined in Section 7 of this method. Compliance shall be determined by comparing the final five-minute pressure with the allowable minimum five-minute final pressure from the first column (1-6 affected nozzles) in Table IB or use the corresponding equation in Section 9.2.

4.3.3 The upstream vapor passage (nozzle to vacuum producing device) shall also be tested. Methodology for this test shall be submitted to the Ohio EPA, Division of Air Pollution Control for approval prior to submission of test results or shall be conducted in accordance with the procedures set forth in the applicable CARB Executive Order.

5. Apparatus

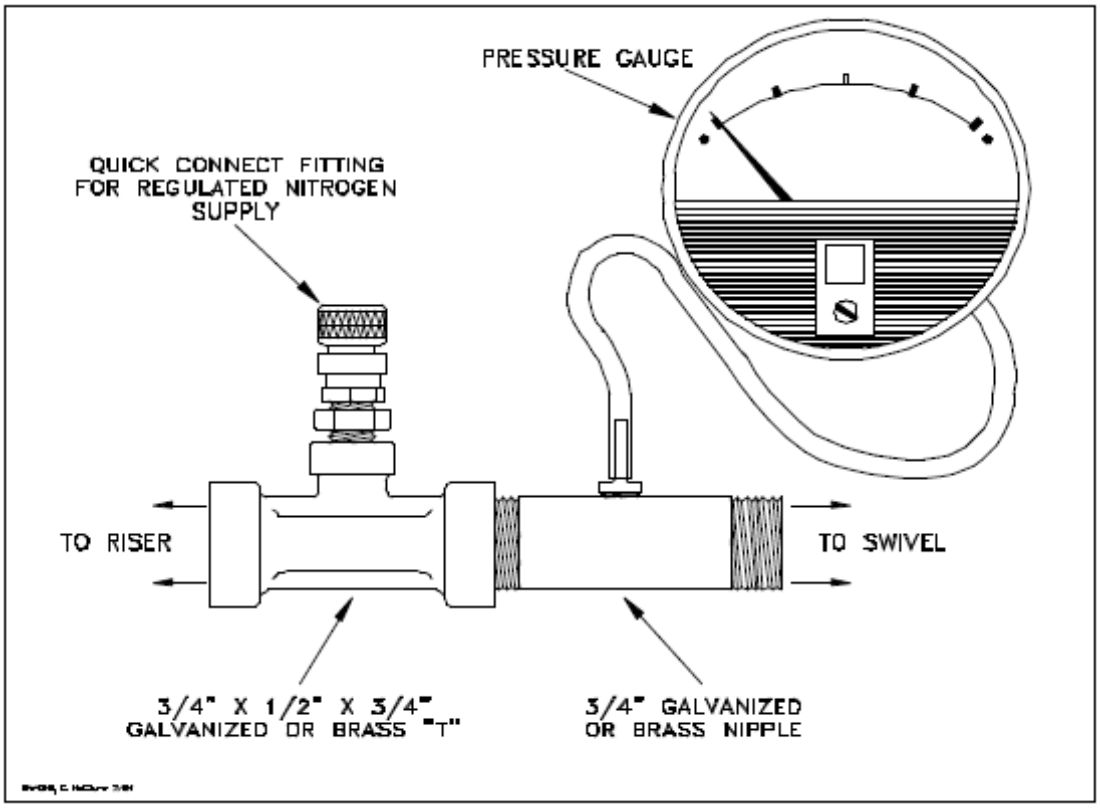
5.1 Nitrogen. Use commercial grade nitrogen in a high pressure cylinder, equipped with a two-stage pressure regulator and a one psig pressure relief valve. A one psig (maximum) pressure relief valve is required and **must** be present. In addition, the cylinder of nitrogen **must** be grounded.

5.2 Pressure Measuring Device. Use 0-2.0, 0-1.0, and 0-0.50 inches H_2O pressure gauges connected in parallel, a 0-2 inches H_2O manometer, or an electronic pressure measuring device to monitor the pressure decay in the vapor control system. The pressure measuring device shall, at a minimum, be readable to the 0.05 inches H_2O.

5.3 "T" Connector Assembly. See Figure 1 for example.

Figure 1

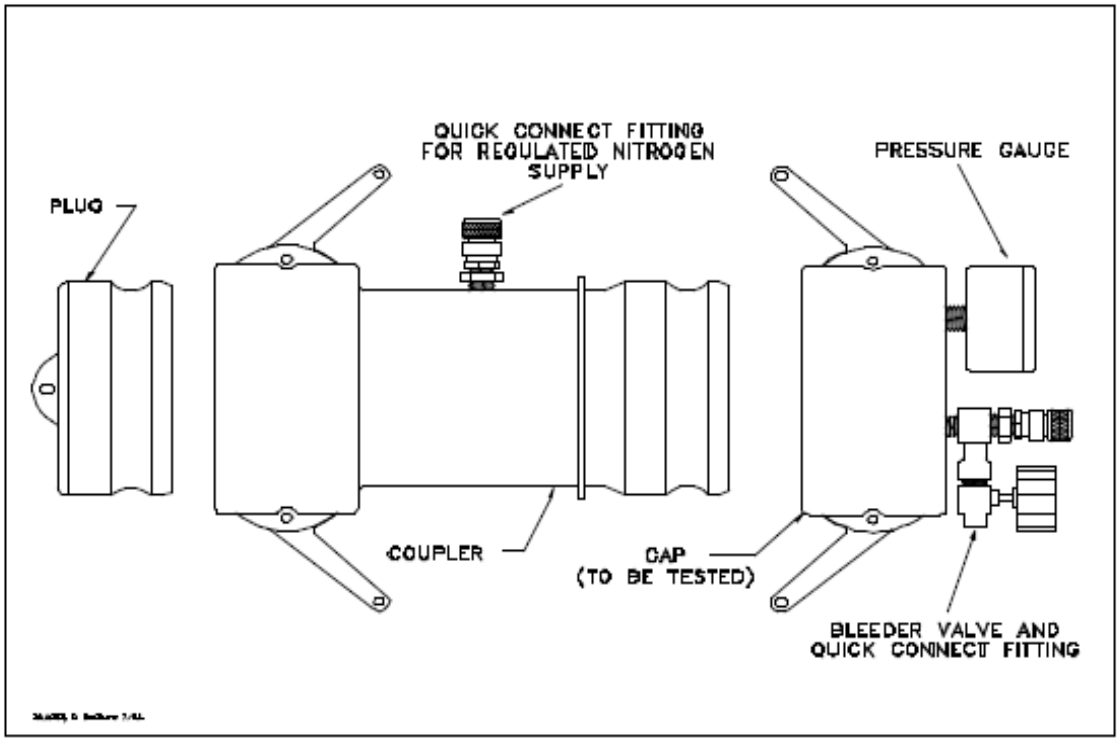
"T" Connector Assembly



5.4 Vapor Coupler Integrity Assembly. Assemble OPW 633-A, 633-B, AND 634-A adapters, or equivalent, as shown in Figure 2. If the test is to be conducted at the storage tank Stage I vapor coupler, this assembly shall be used prior to conducting the static leak test in order to verify the pressure integrity of the vapor poppet. The internal volume of this assembly shall not exceed 0.1 cubic feet.

Figure 2

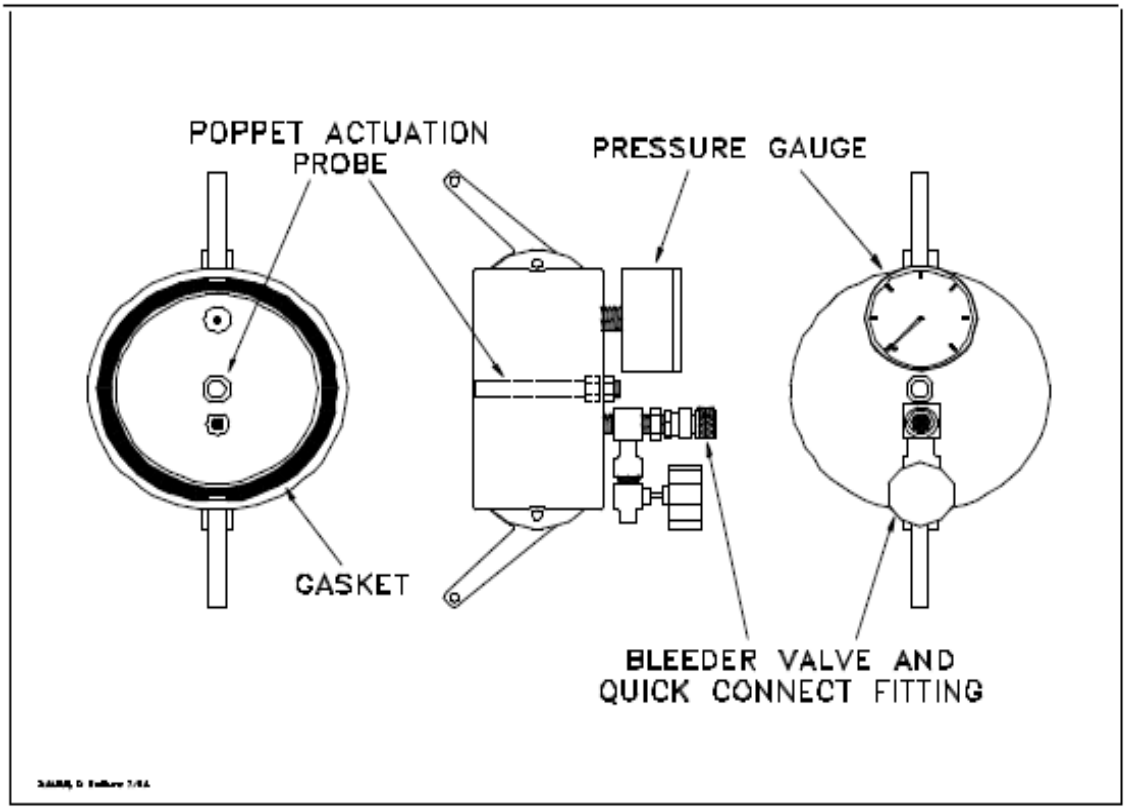
Vapor Coupler Integrity Assembly



5.5 Vapor Coupler Test Assembly. Use a compatible OPW 634-B cap, or equivalent, equipped with a center probe to open the poppet, the appropriate pressure measuring device to monitor the pressure decay, and a connection for the introduction of nitrogen into the system. See Figure 3 for example.

Figure 3

Vapor Coupler Test Assembly



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

5.7 Flowmeter. Use a Dwyer flowmeter, Model RMC-104, or equivalent, to determine the required pressure setting of the delivery pressure gauge on the nitrogen supply pressure regulator. This pressure shall be set such that the nitrogen flowrate is between 1.0 and 5.0 CFM.

5.8 Combustible Gas Detector. A Bacharach Instrument Company, Model 0023-7356, or equivalent, may be used to verify the pressure integrity of system components during this test.

5.9 Leak Detection Solution. Any liquid solution designed to detect vapor leaks may be used to verify the pressure integrity of system components during this test.

6. Pre-Test Procedures

6.1 The following safety precautions shall be followed:

6.1.1 Only grounded nitrogen shall be used to pressurize the system.

6.1.2 A one psig relief valve shall be installed to prevent the possible over-pressurizing of the storage tank.

6.2 Product dispensing shall not occur during the test. There shall have been no Stage I deliveries into or out of the storage tanks within the three hours prior to the test. For vacuum-assist Stage II systems, product dispensing shall not occur during the thirty minutes immediately prior to the test.

6.3 Measure the gallons of gasoline present in each underground storage tank and determine the actual capacity of each storage tank from facility records. Calculate the ullage space for each tank by subtracting the gasoline gallonage present from the actual tank capacity. The minimum ullage during the test shall be 25 percent of the tank capacity (total of **all** tanks if manifolded) or 500 gallons, whichever is greater. The total ullage shall not exceed 25,000 gallons.

6.4 For two-point Stage I systems, this test shall be conducted with the dust cap removed from the vapor coupler. This is necessary to determine the vapor tightness of the Stage I vapor poppet. See Section 6.7 if this test is to be conducted at the Stage I vapor coupler.

6.4.1 For coaxial Stage I systems this test shall be conducted with the dust cap removed from the Stage I coupler. This is necessary to insure the vapor tightness of the Stage I vapor poppet.

6.4.2 Verify that the liquid level in the storage tank is at least four (4) inches above the highest opening at the bottom of the submerged drop tube.

6.5 If the Stage I containment box is equipped with a drain valve, the valve assembly may be cleaned and lubricated prior to the test. This test shall, however, be conducted with the drain valve installed and the manhole cover removed. See subsection 7.4.1 for further details regarding containment box drain valves.

6.6 If the test is to be conducted at a Stage II vapor riser, disconnect the dispenser end of one vapor control hose and install the "T" connector assembly (see Figure 1).

Connect the nitrogen gas supply (do not use air) and the pressure measuring device to the "T" connector.

6.6.1 For those Stage II systems utilizing a dispenser mounted remote vapor check valve, the "T" connector assembly shall be installed on the vapor riser side of the check valve.

6.7 If this test is to be conducted at the Stage I vapor coupler on a two-point Stage I system, the procedures set forth in subsections 6.7.1 and 6.7.2 shall be successfully completed prior to testing. The static leak test shall not be conducted at the Stage I coupler at facilities equipped with coaxial Stage I systems.

6.7.1 Connect the Vapor Coupler Integrity Assembly to the Stage I vapor coupler. Connect the Vapor Coupler Test Assembly. Connect the nitrogen supply to the assembly and carefully pressurize the internal volume of the assembly to two (2.0) inches H_2O. Start the stopwatch. Record the final pressure after one minute.

6.7.2 If the pressure after one minute is less than 0.25 inches H_2O, the leak rate through the Stage I vapor poppet precludes conducting the static leak test at this location. Repair or replace the faulty component(s) as necessary and restart the test pursuant to Section 6.7.1. If the pressure after one minute is greater than or equal to 0.25 inches H_2O, the static leak test may be conducted at this location. This criteria assures a maximum leak rate through the Stage I vapor poppet of less than 0.0004 cubic feet per minute.

6.7.3 Disconnect the Vapor Coupler Integrity Assembly from the Stage I vapor coupler. If the requirements of subsection 6.7.2 were met, install the Vapor Coupler Test Assembly to the Stage I vapor coupler.

6.8 All pressure measuring device shall be bench calibrated using either a reference gauge or incline manometer. Calibration shall be performed at 20, 50, and 80 percent of full scale. Accuracy shall be within two percent at each of these calibration points. Calibrations shall be conducted on a frequency not to exceed 90 days. The individual conducting the test shall supply to the Ohio EPA or its designated local air agency with proof of equipment calibration meeting the requirements of this Section.

6.9 Use the flowmeter to determine the nitrogen regulator delivery pressures which correspond to nitrogen flowrates of 1.0 and 5.0 CFM. These pressures define the allowable range of delivery pressures acceptable for this test procedure. Also

record which regulator delivery pressure setting, and the corresponding nitrogen flowrate, will be used during the test.

6.10 Use Equation 9.3 to calculate the approximate time required to pressurize the system ullage to the initial starting pressure of two (2.0) inches H_2O. This will allow the tester to minimize the quantity of nitrogen introduced into those systems which cannot comply with the static leak standards.

6.11 Attach the Vapor Coupler Test assembly to the Stage I poppet or the "T" connector assembly to the Stage II vapor riser. Read the initial pressure of the storage tank and underground piping. If the initial pressure is greater than 0.5 inches H_2O, carefully bleed off the pressure, in accordance with all applicable safety procedures, in the storage tank and underground piping to less than 0.5 inches H_2O column.

7. Testing

7.1 Open the nitrogen gas supply valve and set the regulator delivery pressure within the allowable range determined in Section 6.9, and start the stopwatch. Pressurize the vapor system (or subsystem for individual vapor return line systems) to **at least** 2.2 inches H_2O initial pressure. It is critical to maintain the nitrogen flow until the pressure stabilizes, indicating temperature and vapor pressure stabilization in the tanks. Check the test equipment using leak detecting solution or a combustible gas detector to verify that all test equipment is leak tight.

7.1.1 If the time required to achieve the initial pressure of two (2.0) inches H_2O exceeds twice the time derived from Equation 9.3, stop the test and use liquid leak detector, or a combustible gas detector, to find the leak in the system. Repair or replace the faulty component and restart the test pursuant to Section 7.1.

7.2 Close and disconnect the nitrogen supply. Start the stopwatch when the pressure has decreased to the initial starting pressure of two (2.0) inches H_2O.

7.3 At one-minute intervals during the test, record the system pressure. After five minutes, record the final system pressure. See the applicable of Table IA (or Equation 9.1) or IB (or Equation 9.2) to determine the acceptability of the final system static pressure results. For intermediate values of ullage in Table IA and IB, linear interpolation may be employed.

7.4 If the system failed to meet the criteria set forth in Table I (or the appropriate equation in Section 9), repressurize the system and check all accessible vapor

connections using leak detector solution or a combustible gas detector. If vapor leaks in the system are encountered, repair or replace the defective component and repeat the test. Potential sources of leaks include nozzle check valves, pressure/vacuum relief valves, containment box drain valve assemblies, and plumbing connections at the risers.

7.4.1 If the facility fails to comply with the static leak test standards and the Stage I system utilizes a non-CARB-certified drain valve equipped containment box, which was installed prior to July 1, 1992, for which a CARB-certified replacement drain valve assembly is not marketed, the following two subsections shall apply:

7.4.1.1 The drain valve may be removed and the port plugged. Retest the system. If the facility complies with the static leak test standards under these conditions, the facility shall be considered complying with the requirements, provided that the manufacturer and model number of the containment box and the date of installation are submitted with the test results.

7.4.1.2 The criteria set forth in subsection 7.4.1.1 shall not apply after July 1, 1996.

7.5 After the remaining system pressure has been relieved, remove the Vapor Coupler Test Assembly or "T" connector assembly and reconnect the vapor control hose, if applicable.

7.6 If the vapor control system utilizes individual vapor return lines, repeat the leak test for each gasoline grade. Avoid leaving any vapor return line open longer than is necessary to install or remove the "T" connector assembly.

8. Post-Test Procedures

8.1 Use the applicable of Table IA or IB, or the applicable of Equations 9.1 or 9.2, to determine the compliance status of the facility by comparing the final five-minute pressure with the minimum allowable final pressure.

8.1.1 For balance Stage II systems use Table IA or the applicable of Equation 9.1 to determine compliance.

8.1.2 For vacuum-assist Stage II systems use Table IB or the applicable of Equation 9.2 to determine compliance.

9. Calculations

9.1 For Stage II Balance Systems, the minimum allowable five-minute final pressure, with an initial pressure of two (2.0) inches H_2O, shall be calculated as follows:

[Equation 9-1]

$P_f = 2e^{\frac{-760.490}{V}}$ if N = 1-6

$P_f = 2e^{\frac{-792.196}{V}}$ if N = 7-12

$P_f = 2e^{\frac{-824.023}{V}}$ if N = 13-18

$P_f = 2e^{\frac{-855.974}{V}}$ if N = 19-24

$P_f = 2e^{\frac{-888.047}{V}}$ if N > 24

Where:

N = The number of affected nozzles. For manifolded systems, N equals the total number of nozzles. For dedicated plumbing configurations, N equals the number of nozzles serviced by the tank being tested.
P_f = The minimum allowable five-minute final pressure, inches H_2O
e = A dimensionless constant approximately equal to 2.718
2 = The initial starting pressure, inches H_2O
V = The total ullage affected by the test, gallons

9.2 For Stage II Vacuum Assist Systems, the minimum allowable five-minute final pressure, with an initial pressure of two (2.0) inches H_2O, shall be calculated as follows:

[Equation 9-2]

$P_f = 2e^{\frac{-500.887}{V}}$ if N = 1-6

$P_f = 2e^{\frac{-531.614}{V}}$ if N = 7-12

$P_f = 2e^{\frac{-562.455}{V}}$ if N = 13-18

$P_f = 2e^{\frac{-593.412}{V}}$ if N = 19-24

$P_f = 2e^{\frac{-624.483}{V}}$ if N > 24

Where:

N = The number of affected nozzles. For manifolded systems, N equals the total number of nozzles. For dedicated plumbing configurations, N equals the number of nozzles serviced by the tank being tested.
P_f = The minimum allowable five-minute final pressure, inches H_2O
e = A dimensionless constant approximately equal to 2.718
2 = The initial starting pressure, inches H_2O
V = The total ullage affected by the test, gallons

9.3 The minimum time required to pressure the system ullage to two (2.0) inches H_2O shall be calculated as follows:

[Equation 9-3]

$$t_2 = V / (1522)F$$

Where:

t_2 = The minimum time to pressurize the ullage to two inches H_2O, minutes
V = The total ullage affected by the test, gallons
F = The nitrogen flowrate into the system, CFM
1522 = The conversion factor for pressure and gallons

9.4 If the policy of the local district requires an allowable tolerance for testing error, the minimum allowable five-minute final pressure, including testing error, shall be calculated as follows:

[Equation 9-4]

$$P_{f\text{-}E} = 2\text{-}\left[\ 1+\left(\frac{E}{100}\right)\right]\ \left[\ 408.9\text{-}\left(\ P_f+406.9\right)\right]$$

Where:

$P_{f\text{-}E}$ = The minimum allowable five-minute final pressure including allowable testing error, inches H_2O
E = The allowable testing error, percent
P_f = The minimum allowable five-minute final pressure calculated in Equations 9-1 or 9-2, inches H_2O
2 = The initial starting pressure, inches H_2O
408.9 = Atmospheric pressure plus the initial starting pressure, inches H_2O
406.9 = Atmospheric pressure, inches H_2O

10. Reporting

10.1 The calculated ullage and system pressures for each five-minute vapor control system test shall be reported as shown in Form 1. Be sure to include the Stage I system type (two-point or coaxial), the Stage II system type, whether the system is manifolded, and the one-minute pressures during the test. The tester may either provide all information listed in Form 1 in the comprehensive test report or include a copy of this form along with the comprehensive written report.

Form 1

Source Test Results
Static Leak Test

Date: _____ Time:_____ Application No._____

GDF Name and address: _____

Stage II system (check one): Vapor Balance [ ]
Vacuum Assist [ ] Type: _____

Stage I type (check one): Two point [ ] Manifolded? Yes [ ]
Coaxial [ ] No [ ]

Tank #				
Product grade				
Actual tank capacity (gallons)				
Gasoline volume (gallons)				
Ullage (gallons)				
Initial pressure of UST, inches H_2O				
Number of nozzles served by tank				
Test location: **(A)** Stage I vapor coupler or **(B)** Stage II riser				
Initial Pressure , inches H_2O **(2.0)**				
Pressure after 1 min. (inches H_2O)				
Pressure after 2 min. (inches H_2O)				
Pressure after 3 min. (inches H_2O)				
Pressure after 4 min. (inches H_2O)				
Final Pressure after 5 min. (inches H_2O)				
Allowable Final Pressure: Table IA, Table 1B, Equations 9.1, 9.2				
Test Status **[Pass** or **Fail]**				

Tests Conducted By: _____
Test Company:_____
Date of Tests:_____
Tests Witnessed By: _____

TABLE IA

STAGE II BALANCE SYSTEMS

PRESSURE DECAY LEAK RATE CRITERIA

INITIAL PRESSURE OF 2 INCHES OF H_2O

MINIMUM PRESSURE AFTER 5 MINUTES, INCHES OF H_2O

	NUMBER OF AFFECTED NOZZLES				
ULLAGE, GALLONS	01-06	07-12	13-18	19-24	> 24
500	**0.44**	**0.41**	**0.38**	**0.36**	**0.34**
550	0.50	0.47	0.45	0.42	0.40
600	**0.56**	**0.53**	**0.51**	**0.48**	**0.46**
650	0.62	0.59	0.56	0.54	0.51
700	**0.67**	**0.64**	**0.62**	**0.59**	**0.56**
750	0.73	0.70	0.67	0.64	0.61
800	**0.77**	**0.74**	**0.71**	**0.69**	**0.66**
850	0.82	0.79	0.76	0.73	0.70
900	**0.86**	**0.83**	**0.80**	**0.77**	**0.75**
950	0.90	0.87	0.84	0.81	0.79
1,000	**0.93**	**0.91**	**0.88**	**0.85**	**0.82**
1,200	1.06	1.03	1.01	0.98	0.95
1,400	**1.16**	**1.14**	**1.11**	**1.09**	**1.06**
1,600	1.24	1.22	1.19	1.17	1.15
1,800	**1.31**	**1.29**	**1.27**	**1.24**	**1.22**
2,000	1.37	1.35	1.32	1.30	1.28
2,200	**1.42**	**1.40**	**1.38**	**1.36**	**1.34**
2,400	1.46	1.44	1.42	1.40	1.38
2,600	**1.49**	**1.47**	**1.46**	**1.44**	**1.42**
2,800	1.52	1.51	1.49	1.47	1.46
3,000	**1.55**	**1.54**	**1.52**	**1.50**	**1.49**
3,500	1.61	1.59	1.58	1.57	1.55
4,000	**1.65**	**1.64**	**1.63**	**1.61**	**1.60**
4,500	1.69	1.68	1.67	1.65	1.64
5,000	**1.72**	**1.71**	**1.70**	**1.69**	**1.67**
6,000	1.76	1.75	1.74	1.73	1.72
7,000	**1.79**	**1.79**	**1.78**	**1.77**	**1.76**
8,000	1.82	1.81	1.80	1.80	1.79
9,000	**1.84**	**1.83**	**1.83**	**1.82**	**1.81**
10,000	1.85	1.85	1.84	1.84	1.83
15,000	**1.90**	**1.90**	**1.89**	**1.89**	**1.89**
20,000	1.93	1.92	1.92	1.92	1.91
25,000	**1.94**	**1.94**	**1.94**	**1.93**	**1.93**

Note:For manifolded Stage II Balance Systems, the **"Number of Affected Nozzles"** shall be the total of all gasoline nozzles. For dedicated return configurations, the **"Number of Affected Nozzles"** shall be the total of those nozzles served by the tank being tested.

TABLE IB

STAGE II ASSIST SYSTEMS

PRESSURE DECAY LEAK RATE CRITERIA

INITIAL PRESSURE OF 2 INCHES OF H_2O

MINIMUM PRESSURE AFTER 5 MINUTES, INCHES OF H_2O

ULLAGE, GALLONS	NUMBER OF AFFECTED NOZZLES 01-06	07-12	13-18	19-24	> 24
500	**0.73**	**0.69**	**0.65**	**0.61**	**0.57**
550	0.80	0.76	0.72	0.68	0.64
600	**0.87**	**0.82**	**0.78**	**0.74**	**0.71**
650	0.93	0.88	0.84	0.80	0.77
700	**0.98**	**0.94**	**0.90**	**0.86**	**0.82**
750	1.03	0.98	0.94	0.91	0.87
800	**1.07**	**1.03**	**0.99**	**0.95**	**0.92**
850	1.11	1.07	1.03	1.00	0.96
900	**1.15**	**1.11**	**1.07**	**1.03**	**1.00**
950	1.18	1.14	1.11	1.07	1.04
1,000	**1.21**	**1.18**	**1.14**	**1.10**	**1.07**
1,200	1.32	1.28	1.25	1.22	1.19
1,400	**1.40**	**1.37**	**1.34**	**1.31**	**1.28**
1,600	1.46	1.43	1.41	1.38	1.35
1,800	**1.51**	**1.49**	**1.46**	**1.44**	**1.41**
2,000	1.56	1.53	1.51	1.49	1.46
2,200	**1.59**	**1.57**	**1.55**	**1.53**	**1.51**
2,400	1.62	1.60	1.58	1.56	1.54
2,600	**1.65**	**1.63**	**1.61**	**1.59**	**1.57**
2,800	1.67	1.65	1.64	1.62	1.60
3,000	**1.69**	**1.68**	**1.66**	**1.64**	**1.62**
3,500	1.73	1.72	1.70	1.69	1.67
4,000	**1.76**	**1.75**	**1.74**	**1.72**	**1.71**
4,500	1.79	1.78	1.77	1.75	1.74
5,000	**1.81**	**1.80**	**1.79**	**1.78**	**1.77**
6,000	1.84	1.83	1.82	1.81	1.80
7,000	**1.86**	**1.85**	**1.85**	**1.84**	**1.83**
8,000	1.88	1.87	1.86	1.86	1.85
9,000	**1.89**	**1.89**	**1.88**	**1.87**	**1.87**
10,000	1.90	1.90	1.89	1.88	1.88
15,000	**1.93**	**1.93**	**1.93**	**1.92**	**1.92**
20,000	1.95	1.95	1.94	1.94	1.94
25,000	**1.96**	**1.96**	**1.96**	**1.95**	**1.95**

Note: For manifolded Stage II Assist Systems, the **"Number of Affected Nozzles"** shall be the total of all gasoline nozzles. For dedicated return configurations, the **"Number of Affected Nozzles"** shall be the total of those nozzles served by the tank being tested.