California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

TP-201.2F

Pressure-Related Fugitive Emissions

Adopted: February 1, 2001

Note: **This procedure is being adopted. Because all the text is affected, for ease of viewing, the underline is omitted as allowed by title 1, California Code of Regulations, section 8.**

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PRESSURE-RELATED FUGITIVE EMISSIONS

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 "CARB" refers to the State of California Air Resources Board, and the term "Executive Officer" refers to the CARB Executive Officer, or his or her authorized representative or designate.

1. PURPOSE AND APPLICABILITY

1.1 The purpose of this test procedure is to quantify the mass of organic compounds emitted from pressure-related fugitive leak sources during the CARB Certification Process. It is applicable to the determination of compliance with the efficiency and emission factor standards specified in Section 4 of the Certification Procedure (CP-201) for those systems that generate a positive gauge pressure on the vapor containment space of the underground storage tank (UST).

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

2.1 The volumetric leak rate from pressure-related fugitive leak sources is determined by conducting pressure decay tests during the certification process as follows:

2.1.1 Conduct pressure decay tests at least monthly during the 180-day operational test.

2.1.2 Conduct pressure decay tests before and after conducting test procedure TP-201.2. The initial pressure decay test shall be conducted between 24 and 72 hours prior to conducting TP-201.2. The post-TP-201.2 pressure decay test shall be conducted within 24 hours of the completion of TP-201.2.

The actual gauge pressure in the vapor containment space of the UST is monitored and the hydrocarbon concentration of the gasoline vapors at the fugitive leak sources is also measured, or a default saturated concentration is assumed. The mass of the pressure-related fugitive emissions is calculated using the volumetric leak rate from the pressure decay tests, the actual monitored pressure, and the hydrocarbon concentration of the gasoline vapor.

2.2 The primary elements for the pressure decay portion of the procedure are as follows:

2.2.1 The minimum and maximum allowable combined ullages are 2,000 and 15,000 gallons.

2.2.2 For all Phase II system types, product dispensing shall not occur during the sixty (60) minutes immediately prior to the test.

2.2.3 The initial pressure for the pressure decay test is 2.00 inches H_2O and the test duration is twenty (20.0) minutes.

2.2.4 The procedure includes limits on the rate of vapor growth and the change in ambient temperature immediately prior to conducting the pressure decay portion of the procedure.

3. BIASES AND INTERFERENCES

3.1 The location(s) chosen to measure the hydrocarbon concentration may not represent the hydrocarbon concentration that is emitted at every potential fugitive leak point in the vapor system. The selected location should represent the concentration at the top of the UST.

3.2 If the default hydrocarbon concentration is used, the calculated pressure-related fugitive emissions will be higher than the actual emissions.

3.3 Systems with a negative gauge pressure in the vapor containment space of the UST prior to conducting the pressure decay portion of this procedure will be biased toward lower fugitive leakrates if air is allowed to bring the system from negative gauge to zero gauge pressure. This bias will be minimized if nitrogen is used to bring the pressure from negative gauge to zero gauge pressure.

3.4 Changes in the pressure integrity of the facility between pressure decay tests will bias the pressure-related fugitive test results. To minimize this bias, the pressure-related fugitive emissions shall be calculated using the results from both pressure decay tests surrounding the fugitive emission test period. Arithmetic averages of the two results shall be used, unless data from the pressure monitoring isolates the time of the change in pressure integrity.

4. SENSITIVITY, RANGE, AND PRECISION

4.1 The sensitivity of the pressure measuring device shall be 0.01 inches H_2O for the electronic pressure measuring device.

4.2 During the pressure decay portion of the procedure, the minimum and maximum total ullages shall be 2,000 and 15,000 gallons, respectively. These volumes are exclusive of all vapor piping volumes.

4.3 During the pressure decay portion of the procedure, the minimum and maximum nitrogen feed-rates into the system shall be one (1.0) and five (5.0) CFM, respectively. The sensitivity of the flowmeter used to verify the nitrogen flowrates shall be 0.1 CFM.

4.4 The hydrocarbon analyzer specified in Section 5.7 shall be capable of accurately measuring hydrocarbon concentrations between 15 and 45 percent, as C_4 (20 to 60 percent as C_3).

4.5 The pressure transducer used to continuously monitor the pressure in the UST vapor containment space shall be accurate to within 0.05 inches H_2O.

4.6 The datalogger used to record the UST vapor containment space pressure shall be capable of recording data points at a minimum frequency of five seconds per data point.

5. EQUIPMENT

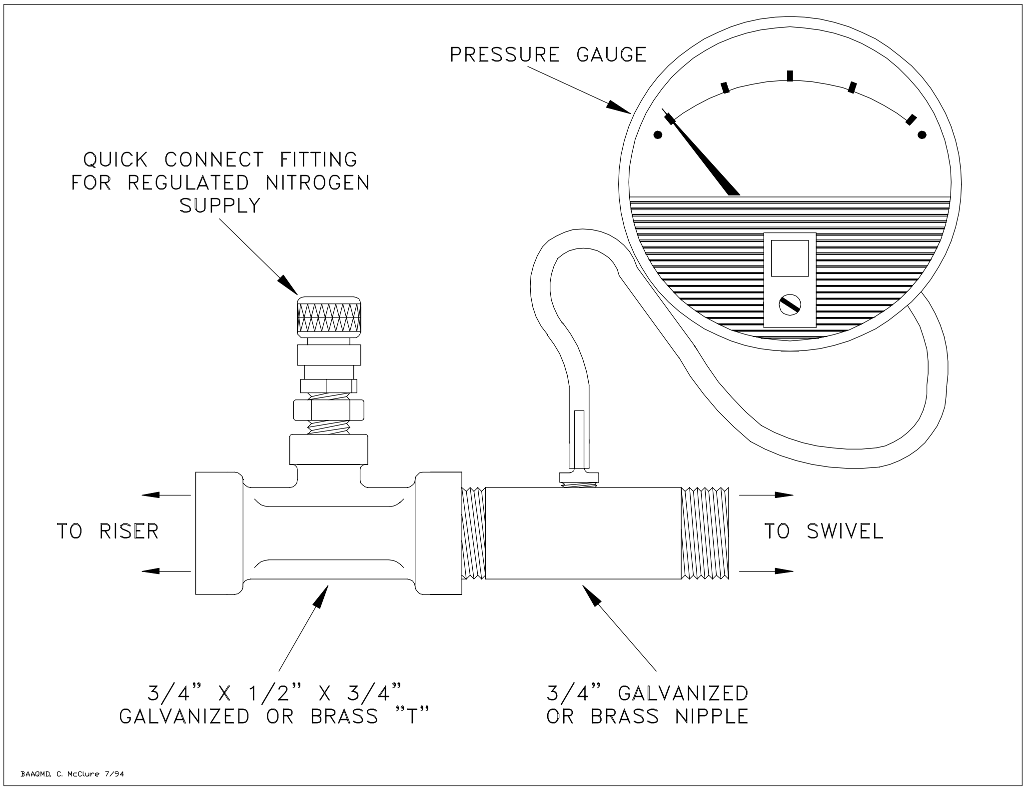
5.1 Nitrogen. Use commercial grade gaseous nitrogen in a high pressure cylinder, equipped with a two-stage pressure regulator and a one psig pressure relief valve.

5.2 Electronic Pressure Measuring Device. Use an electronic pressure measuring device with a maximum fullscale range of 10 inches H_2O and a minimum accuracy of 0.5 percent to monitor the pressure decay in the vapor recovery system during the pressure decay portion of the procedure. The pressure measuring device shall, at a minimum, be readable to the nearest 0.01 inches H_2O.

5.3 "T" Connector Assembly. See Figure 1 for example. This component is used if the pressure decay portion of the procedure is conducted at a Phase II vapor riser.

Figure 1

"T" Connector Assembly



5.4 Vapor Coupler Test Assembly. If the pressure decay portion of the procedure is conducted at a Phase I vapor coupler, use a compatible cap, equipped with a center probe to open the poppet and a pressure measuring device to monitor the pressure decay in the vapor containment space of the UST. The Vapor Coupler Test Assembly shall include a connection for the introduction of nitrogen into the system. See Figure 2 for an example. This device shall also be used to determine the rate of vapor growth prior to beginning the pressure decay portion of the procedure.

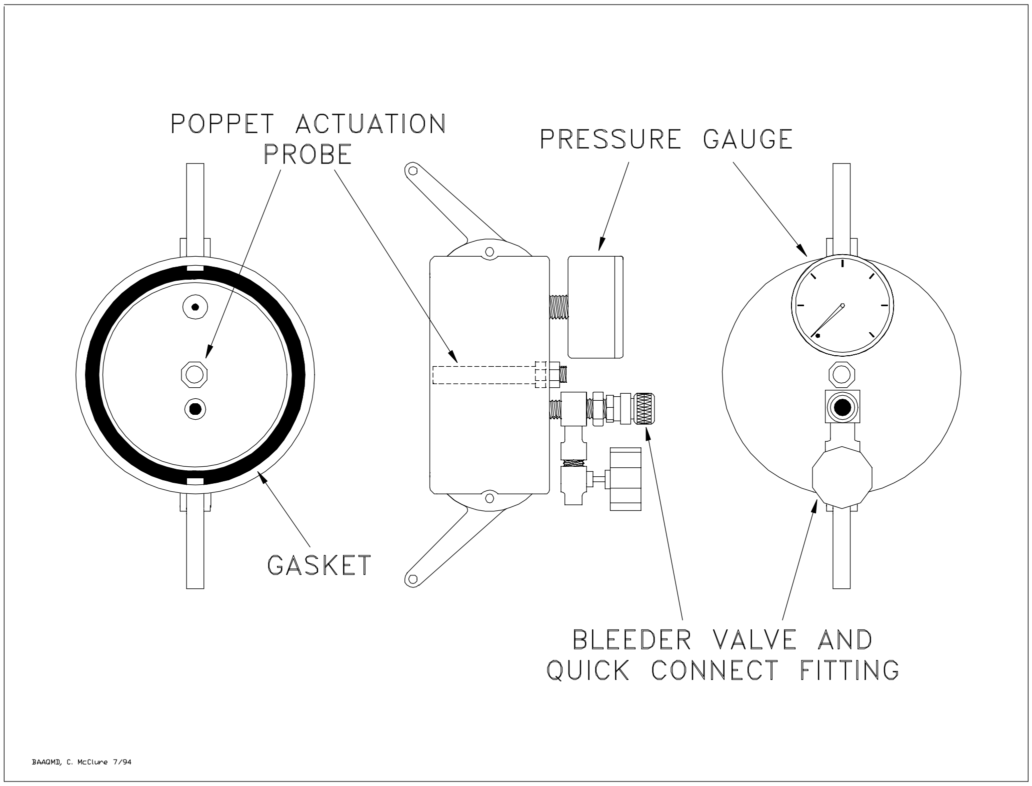
5.5 Stopwatch. Use a stopwatch accurate to within 0.2 seconds.

5.6 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.

5.7 Hydrocarbon Analyzer. Use a Flame Ionization Detector (FID) or Non-Dispersive Infrared (NDIR) hydrocarbon Analyzer to continuously monitor the hydrocarbon concentration of the containment space of the UST. The FID or NDIR shall be calibrated using either propane or butane.

5.8 Pressure Transducer and Electronic Data Recording Device. Use a pressure transducer accurate to within 0.05 inches H_2O to continuously monitor the pressure in the UST vapor containment space. The data shall be continuously recorded using either a datalogger or strip chart recorder. The datalogger shall be capable of recording data points at a minimum frequency of five seconds.

Figure 2
Vapor Coupler Test Assembly



5.9 Tank Gauging Stick. Use a tank gauging stick of sufficient length to verify that the UST liquid level is at least four (4) inches above the highest opening at the bottom of the submerged drop tube. The tank gauging stick shall be equipped with a non-sparking “L” bracket at the end.

5.10 Ambient Temperature Measuring Device. Use a thermometer or electronic temperature measuring device, accurate to ± 2 degrees Fahrenheit, to monitor the change in ambient temperature during the pressure decay portion of the procedure.

6. PRE-TEST PROCEDURES

6.1 The following requirements shall be adhered to in all cases:

6.1.1 Only gaseous nitrogen shall be used to pressurize the system during the pressure decay portion of the procedure.

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

6.1.3 A ground strap shall be employed during the introduction of nitrogen into the system during the pressure decay portion of the procedure.

6.2 Product dispensing shall not occur during the pressure decay portion of the procedure. There shall have been no Phase I deliveries into or out of the UST storage tanks within the three hours immediately prior to the test. Product dispensing shall not occur during the sixty (60) minutes immediately prior to the pressure decay portion of the procedure.

6.3 Measure, or determine, 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 pressure decay portion of the procedure shall be 2,000 gallons. The total ullage shall not exceed 15,000 gallons.

6.4 For two-point Phase I systems, the pressure decay portion of the procedure shall be conducted with the cap removed from all Phase I vapor couplers. This is necessary to determine the pressure integrity of the Phase I vapor poppet.

6.4.1 For coaxial Phase I systems, this test shall be conducted with the cap removed from the Phase I coupler. This is necessary to insure the vapor tightness of the Phase 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. This may be accomplished by using a tank gauging stick equipped with a non-sparking “L” bracket on the end.

6.5 The pressure decay portion of the procedure shall be conducted with the Phase I containment box drain valve(s) (if applicable) installed and the manhole cover removed.

6.6 If the pressure decay portion of the procedure is to be conducted at a Phase II vapor riser, disconnect the dispenser end of one vapor recovery 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.

6.7 All pressure measuring device(s) shall be bench calibrated using either a reference gauge or incline manometer. Calibrations shall be performed at 20, 50, and 80 percent of full scale. Accuracy shall be within 0.5 percent at each of these calibration points. Calibrations shall be conducted on a frequency not to exceed 180 days.

6.8 Use the flowmeter to determine the correlation between the nitrogen regulator delivery pressures and nitrogen flowrates of 1.0 and 5.0 CFM. These pressures define the allowable range of delivery pressures acceptable for the pressure decay portion of the test procedure. Also record the regulator delivery pressure setting, and the corresponding nitrogen flowrate that will be used during the test. As an alternative, the flowmeter may be connected in-line, between the nitrogen supply regulator and Vapor Coupler Test Assembly or “T” Connector, during the procedure.

6.9 Use Equation 9.4 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 containing leaks large enough to prevent the system from achieving the initial pressure of two (2.0) inches H_2O.

6.10 Position the ambient temperature measuring device in a location not subject to shade.

7. TEST PROCEDURE

7.1 Use the FID hydrocarbon analyzer to continuously monitor the hydrocarbon concentration at either the top of the UST, using the Phase I vapor connector, for a minimum of sixty (60) minutes, or as specified by CARB, prior to conducting the pressure decay portion of the procedure. Continuous sampling shall be conducted in accordance with USEPA Method 25A, “Determination of Total Gaseous Organic Concentration Using a Flame Ionization Analyzer” (40 CFR, Part 60 , App. A). EPA Method 18, “Measurement of Gaseous Organic Compound Emissions by Gas Chromatography” (40 CFR, Part 60, App. A) may be used to determine the hydrocarbon concentration, provided the collected sample is integrated over a period not less than 60 minutes, or as specified by the Executive Officer. The sampling shall not be conducted while the pressure decay portion of the procedure is being conducted.

7.1.1 In lieu of measuring the vapor hydrocarbon concentration, the vapor hydrocarbon concentration of the gasoline vapor can be assumed to be 38 percent, as C_4 (50 percent as C_3). This assumed-value approach may only be employed with the prior approval of the Executive Officer.

7.2 Attach the Vapor Coupler Test Assembly to the Phase I poppet or the "T" connector assembly to the Phase II vapor riser. Read the initial pressure of the storage tank vapor containment space. If the initial pressure is greater than or less than zero (0.00) inches H_2O gauge, carefully bleed off the pressure, in accordance with all applicable safety procedures, from the vapor containment space of the UST to zero (0.00) inches H_2O gauge. Start the stopwatch.

7.2.1 After ten (10.0) minutes, record the storage tank vapor containment space pressure. If the pressure exceeds ±0.02 inches H_2O gauge, bleed off the pressure and repeat this Section. Continue this process until the ten-minute pressure change is between ±0.02 inches H_2O.

7.3 Open the nitrogen gas supply valve and set the regulator delivery pressure within the allowable range determined in Section 6.8, 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.

7.3.1 Use the results of Equation 9.4 to determine if the system leaks exceed the nitrogen feed rate.

7.4 Close and disconnect the nitrogen supply. Start the stopwatch when the pressure has decreased to the initial starting pressure of 2.0 inches H_2O. In some cases it may be necessary to bleed off pressure to reach the initial starting pressure of 2.00 inches H_2O. Record the ambient temperature.

7.5 At one-minute intervals during the test, record the system pressure. After twenty (20) minutes, stop the stopwatch and record the final system pressure and the ambient temperature.

7.6 If the vapor recovery system utilizes individual vapor return lines and the vapor containment space of the USTs are not manifolded, repeat the pressure decay portion of the procedure for each UST. Avoid leaving any vapor return line open longer than is necessary to install or remove the "T" connector assembly.

7.7 Use the pressure transducer and electronic data recording device to continuously monitor the pressure in the UST vapor containment space. Record the total number of gallons dispensed during the time that pressure data is being collected.

7.8 If the change in ambient temperature during the twenty minute pressure decay portion of this procedure exceeded five (5.0) degrees Fahrenheit, the results of the pressure decay test shall not be used, and the test shall be repeated.

8. POST-TEST PROCEDURES

8.1 After the pressure decay portion of the procedure has been completed, and after the remaining system pressure has been relieved, remove the "T" connector assembly, if applicable, and reconnect the vapor recovery hose or remove the vapor coupler test assembly from the Phase I vapor coupler, as applicable.

8.2 Use Equations 9.1 to calculate the pressure-related fugitive flowrate.

8.3 Use Equation 9.2 to calculate the mass emission rate of pressure-related fugitives.

8.4 Use Equation 9.3 to calculate the mass emission factor of pressure-related fugitive emissions.

8.5 Reduce the data to tabulate the duration of each positive gauge pressure, or pressure range, as shown in Form 1. If the UST pressure data is reduced as pressure ranges, each range shall not exceed 0.25 inches H_2O, and the midpoint of each range shall be used to calculate the pressure-related fugitive flowrates. Report all data shown in Form 1.

9. CALCULATING RESULTS

9.1 The pressure-related fugitive flowrate shall be calculated as follows:

where:

Q = Pressure-related fugitive flowrate, cubic feet per hour (ft^3/hour)
V = Total ullage affected by the test, gallons
P_{act} = Actual pressure measured in UST containment space, inches H_2O
P_f = Final gauge pressure from pressure decay test portion of test, inches H_2O
60 = Conversion factor for minutes to hours, minutes/hour
2.00 = Initial gauge pressure from pressure decay portion of test, inches H_2O
20 = Twenty minutes
7.481 = Conversion factor for gallons to cubic feet, gallons/ft^3
406.9 = Atmospheric pressure, inches H_2O

9.2 The mass emission rate of pressure-related fugitive emissions shall be calculated as follows:

$$M = \left[\frac{(Q)(C)(MW)}{(386.9)(100)}\right] \qquad \text{Equation 9.2}$$

where:

M = Mass rate of fugitive emissions, lb/hour
C = Hydrocarbon concentration, percent (C_3 or C_4)
MW = Molecular weight, lb/lb-mole [44.096 for C_3 or 58.123 for C_4]
386.9 = Molar volume, ft^3/lb-mole
100 = Conversion factor for percent to mole fraction

9.3 The mass emission factor for pressure-related fugitive emissions shall be calculated as follows:

$$E_{PRF} = \left[\frac{(M)(t_{act})(1{,}000)}{(G_{act})}\right] \qquad \text{Equation 9.3}$$

Where:

E_{PRF} = Emission factor for pressure-related fugitives, lb/1,000 gallons
t_{act} = Duration of the test, hours
G_{act} = Gallons dispensed during the test, gallons
1000 = Conversion factor, dimensionless

9.4 The minimum time required to pressurize the system ullage from zero (0) to an initial pressure of 2.00 inches H_2O shall be calculated as follows:

$$t_{Pi} = \left[\frac{V\left(\left(\frac{406.9 + 2.00}{406.9}\right) - 1\right)}{(7.481)(Q_N)} \right] \qquad \text{Equation 9.4}$$

Where:

t_{Pi} = Minimum time to pressurize the ullage to 2.00 inches H_2O, minutes
V = Total ullage affected by the test, gallons
2.00 = Initial starting pressure for the test, inches H_2O
Q_N = Nitrogen flowrate into the system, CFM
7.481 = Conversion factor for gallons to cubic feet, gallons/ft^3

9.5 A sample calculation is shown in Section 12.

10. REPORTING RESULTS

10.1 Report the results of the test as shown in Form 1.

11. ALTERNATE PROCEDURES

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

12. EXAMPLE CALCULATION

An example calculation, demonstrating the method of determining pressure-related fugitive emissions based on the leak decay rate, the hydrocarbon concentration, and the measured pressure, is shown below:

Given:

Pressure Decay Portion of Procedure

Ullage	**10,000**
Initial Pressure, inches H_2O	**2.00**
Final Twenty-Minute Pressure, inches H_2O	**1.52**
Atmospheric Pressure, inches H_2O	**406.9**

Hydrocarbon Measurement Portion of Test

Hydrocarbon Concentration, % as C_3	**36.0**

Pressure Measurement Portion of Test

Test duration, hours	**24.0**
Gallons Dispensed during Test, gallons	**8,500**

Positive Gauge Pressures:
1.5 inches H_2O for 4.5 hours
2.0 inches H_2O for 7.5 hours
3.0 inches H_2O for 5.0 hours

Find: The hydrocarbon pressure-related fugitive emissions leak rate, mass emission rate of pressure-related fugitives, and the mass emission factor of pressure-related fugitives.

Use Equation 9.1, inserting the different values of the actual measured pressures of 1.5, 2.0, and 3.0 inches H_2O for P_{act}.

$$Q = (60\,\text{min/hr})\left[\frac{(10{,}000\,\text{gallons})(2.00-1.52)}{(20)(7.481)(406.9)\left(2.00\left(\frac{1.52}{2.00}\right)^{1/2}\right)^{1/2}}\right](P_{act})^{1/2}$$

This results in the following pressure-related fugitive flowrates, in CFH, at the various measured pressures during the 24 hour test period :

$Q_{1.5} = 4.388$ CFH
$Q_{2.0} = 5.067$ CFH
$Q_{3.0} = 6.205$ CFH

The average pressure-related fugitive flowrate, in CFH during the 24 hour test is calculated as follows:

$$Q = \left(\frac{(4.388\,\text{cfh})(4.5\,\text{hr}) + (5.067\,\text{cfh})(7.5\,\text{hr}) + (6.205\,\text{cfh})(5.0\,\text{hr})}{(24\,\text{hr})}\right)$$

$$Q = \left(\frac{88.774}{24}\right) = 3.700\,\text{cfh}$$

The average mass emission rate of pressure-related fugitive emissions during the 24 hour test is calculated from Equation 9.2 as follows:

$$\mathrm{M} = \left[\frac{(3.700\,\mathrm{cfh})(36\%)(44.096\,\mathrm{lb/lb-mole})}{(386.9\,\mathrm{ft}^3/\mathrm{lb-mole})(100\%)} \right] = 0.152\,\mathrm{pounds/hour}$$

The mass emission factor for pressure-related fugitive emissions is calculated from Equation 9.3 as follows:

Form 1

TP-201.2F Reporting Form

Summary of Pressure-Related Fugitive Emissions

GDF Name ______________________________
GDF Address ____________________________
City ____________________________________
Telephone # _____________________________

Phase II System Type ________________________________
Phase I Type _______________________________________
Total # of Dispensers _______________________________
Total # of Nozzles __________________________________

TP-201.2F Results

2 Inch H_2O Pressure Decay Results

Test Date:

	Tank 1 Grade ________	Tank 2 Grade ________	Tank 3 Grade ________
Capacity, gal			
Gallonage, gal			
Ullage			
Total Ullage, gal			

Initial Pressure, P_i = 2.00 inches H_2O

+1 Minute ____________ +11 Minutes _____________
+2 Minutes ____________ +12 Minutes _____________
+3 Minutes ____________ +13 Minutes _____________
+4 Minutes ____________ +14 Minutes _____________
+5 Minutes ____________ +15 Minutes _____________
+6 Minutes ____________ +16 Minutes _____________
+7 Minutes ____________ +17 Minutes _____________
+8 Minutes ____________ +18 Minutes _____________
+9 Minutes ____________ +19 Minutes _____________
+10 Minutes ____________ **+20 Minutes [P_f]** _________

Hydrocarbon Measurement Results

Calibration Gas, propane or butane _______________
Method, FID, Method 18, Other _________________
Hydrocarbon Concentration, % __________________
Duration of Sampling, hours _____________________

Pressure Measurement and Throughput Results

Test Dates and Times
Start Date _____________ Start Time _____________
End Date _____________ End Time ______________

Duration of Pressure Measurements ___________ hours
Total Hours of Positive Gauge Pressure ________ hours
Total Throughput During Test, _______________ gallons

Pressure Range, Inches H_2O	**Duration in Range, Hours**	**Arithmetic Midpoint of Pressure Ranges**	**Pressure-Related Fugitive Flowrate, CFH [From Equation 9.1]**
TOTALS			