California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

TP-201.1

Volumetric Efficiency for Phase I Systems

Adopted: April 12, 1996
Amended: February 1, 2001

Note: This procedure is being amended. For ease of viewing, the method is shown as adopted text in the version that precedes this version. The method is shown as repealed text in this version. Strike-out and underline have been omitted as authorized by title 2, California Code of Regulations, section 8.

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TP-201.1

VOLUMETRIC EFFICIENCY OF PHASE I SYSTEMS

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 procedure is to quantify the Phase I volumetric efficiencies during bulk gasoline deliveries at gasoline distribution facilities (GDF). It is applicable for those facilities which are not equipped with post processor systems, such as Hirt or Hasstech Phase II systems.

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

2.1 During a bulk gasoline delivery, the volume of gasoline delivered from the cargo tank to the GDF storage tank is recorded. The volume of gasoline vapor discharged from the vent pipe(s) of the storage tank(s) is measured. From these parameters the Phase I volumetric efficiency is determined. If a Phase I system fails to meet 98% volumetric efficiency, the gasoline cargo tank shall be tested for compliance with the year-round (daily) standards for gasoline cargo tanks, contained in CP-204, to determine if the failure could be attributed to the cargo tank.

3. BIASES AND INTERFERENCES

3.1 Any vapor leaks exceeding 100 % of the Lower Explosive Limit (LEL) during the gasoline bulk delivery precludes the use of this method.

3.2 Gasoline cargo tanks exceeding the allowable year-round (daily) pressure-decay standards, as defined in CP-204, preclude the use of this method.

3.3 Unusually large cargo tank headspace volumes may cause low volumetric efficiencies under certain thermal conditions. Conversely, unusually small headspace volumes may result in abnormally high efficiencies. During the Certification Process for a Phase I system, the cargo tank headspace volumes should be between 3.0 and 10.0 percent of the total cargo tank capacity prior

to the delivery.

4. SENSITIVITY, RANGE AND PRECISION

4.1 If mechanical pressure gauges are employed, the minimum readability of the pressure gauges shall be 0.2 inches H_2O and the minimum accuracy of the gauge shall be three percent of full scale. The diameter of the pressure gauge face shall be four inches or greater.

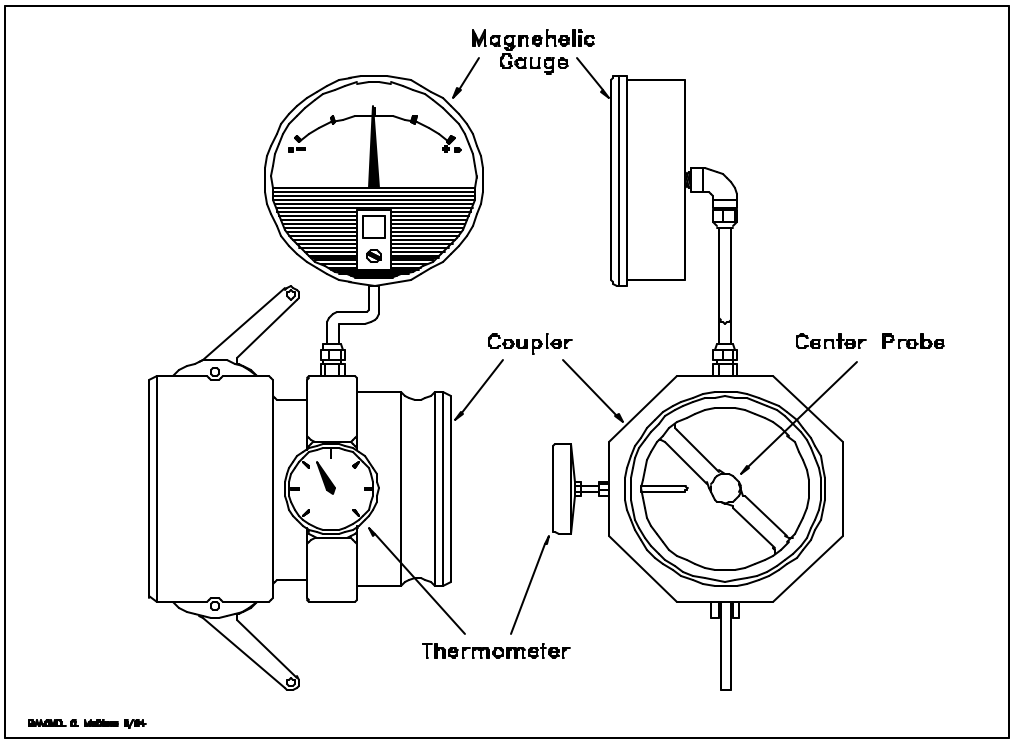
4.2 If an electronic pressuring device is used, the full scale range of the device shall not exceed 0 to 10 inches H_2O with a minimum accuracy of 0.5 percent of full scale. A 0 to 20 inches H_2O device may be used, provided the equivalent accuracy is not less than 0.25 percent of full scale.

5. EQUIPMENT

5.1 Positive Displacement Meter(s). Use a rotary type positive displacement meter(s) with a back pressure less than 1.1 inches H_2O at a flowrate of 3,000 CFH. The meter shall be equipped with a 0 to 1 inch H_2O pressure gauge and a 0 to 150^{O}F thermocouple on the inlet side.

Figure 1

Cargo Tank Pressure Assembly



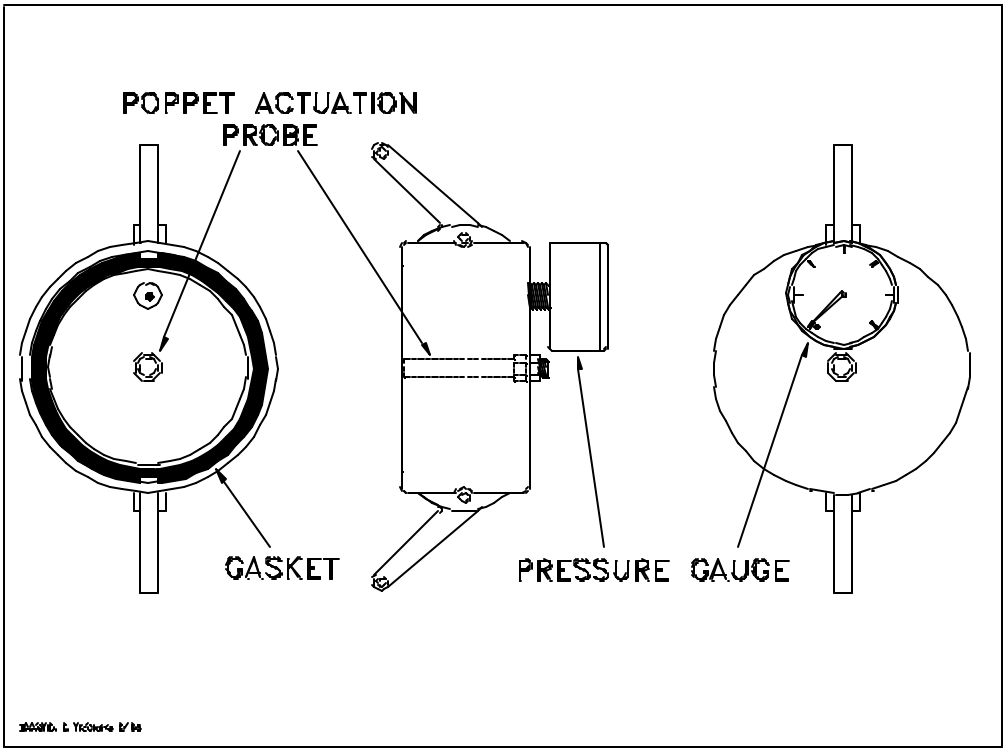
5.2 Flexible Tubing. Use 2.5 inch ID Flexhaust tubing, or equivalent, to connect the vent pipe outlet to the inlet of the rotary positive displacement meter. The length of the tubing shall be the minimum required for proper connection.

5.3 Cargo Tank Pressure Assembly. Use OPW® 633-F and 633-D couplers, or equivalent, as shown in Figure 1. The assembly shall be equipped with a thermometer and a pressure gauge, or manometer (oil or water), capable of measuring -10 to +10 inches H_2O pressure at the gasoline cargo tank vapor coupler.

5.4 Storage Tank Pressure Assembly. For two-point Phase I systems, use a compatible OPW® 634-B cap(s), or equivalent, equipped with a 0 to 0.5 inches H_2O pressure gauge and a center probe as shown in Figure 2. This equipment is only required if a test is conducted on a manifolded vapor recovery system.

Figure 2

Storage Tank Pressure Assembly



5.5 Combustible Gas Detector. Use a Bacharach Instrument Company Model 0023-7356®, or equivalent, to quantify any vapor leaks occurring during the gasoline bulk drop.

5.6 Barometer. Use a mercury, aneroid, or equivalent barometer accurate to within 1 millimeters of mercury (0.04 inches of mercury).

5.7 Thermometers. Use three thermometers, or equivalent, with a range of 0 to 150 ^{O}F and accurate to within 2 ^{O}F.

5.8 Stopwatch. Use a stopwatch accurate to within 0.2 seconds to time the delivery rate of gasoline during the bulk drop.

6. PRE-TEST PROCEDURES

6.1 The positive displacement meter shall be calibrated against a standard reference meter prior to its initial use in the field and at intervals not to exceed 180 days. The reference meter shall be either a spirometer or wet-test meter with a capacity applicable for the specific mater to be calibrated. Calibration shall be performed at a minimum of three flowrates representing approximately 25, 50 and 75 percent of rated capacity.

6.2 Perform a visual inspection of all storage tank couplers. Inspect all vapor connections at the gasoline dispensers if Phase II vapor recovery is present.

6.3 Connect the positive displacement meter to the appropriate storage tank vent pipe using the flexible tubing. If the Phase I is manifolded, or if a "normal" non-manifolded delivery consists of simultaneous delivery of more than one product grade, connect one positive displacement meter to each storage tank vent pipe Alternatively, flexible tubing may be used to construct a temporary manifold into a single positive displacement meter. The meter shall be as close as possible to the vent pipe outlets.

6.4 Record the gas grade, capacity, and ullage for each storage tank on the Phase I Vapor Recovery Data Sheet (Form 1).

6.5 Record, on the Phase I Vent Pipe Data Sheet (Form 2), the initial meter readings from the positive displacement meter.

6.6 Record, on the Phase I Vapor Recovery Data Sheet, the barometric pressure.

6.7 Connect the Cargo Tank Vapor Assembly to the vapor coupler on the gasoline cargo tank. If the cargo tank vapor coupler is equipped with a poppet, use a pressure assembly with a center probe.

6.8 If a manifolded vapor recovery system with a two-point Phase I system is being tested, install a Storage Tank Pressure Assembly on the Phase I vapor connections of those tanks not receiving product. During each bulk drop record the maximum pressure in those tanks. For coaxial Phase I systems the pressure may be measured at the dispensers.

6.9 Insure that no vehicle refueling will occur during the bulk gasoline delivery.

7. TESTING

7.1 Record, on the Phase I Vapor Recovery Data Sheet (Form 1), the gasoline grade(s) and quantities delivered during each bulk drop. Also record, on the Phase I Cargo Tank Data Sheet (Form 3), the cargo tank CT#, CARB decal number, expiration date, and the cargo tank compartment capacities.

7.2 Start the stopwatch when the bulk delivery begins and stop the stopwatch at the conclusion of the delivery. If possible, the delivery rate should be determined for each cargo tank compartment.

7.3 Record the following parameters every 15 seconds during each gasoline bulk drop:

7.3.1 Meter readings, temperatures and pressures at the positive displacement meter. Extreme care must be taken to record all positive displacements since occasional reverse flow conditions may occur. Record this data on the Phase I Vent Pipe Data Sheet (Form 1).

7.3.2 Vacuum (or pressure) and temperature at the cargo tank pressure assembly attached to the cargo tank vapor coupler. Record this data on the Phase I Cargo Tank Data Sheet (Form 3).

7.4 Continue to monitor the vent pipe emissions for a period of one hour after the bulk drop has been completed. During this one hour period the data collection required in 7.3.1 shall be recorded at 5 minute intervals. These emissions are to be included in the Phase I efficiency calculation.

8. POST TEST PROCEDURES

8.1 At the conclusion of the bulk drop, remove the Cargo Tank Pressure Assembly from the cargo tank and the Storage Tank Pressure Assembly(s) from the storage tank(s).

8.2 Disconnect all instrumentation from the storage tank vent pipe(s) after concluding the one hour post-drop portion of the test.

8.3 Verify the quantities of gasoline delivered to each storage tank.

8.4 Record the final meter reading(s) at the storage tank vent pipe(s).

9. CALCULATING RESULTS

9.1 The volume of vapors discharged through "i-th" vent shall be calculated as follows:

$$V_{vsi} = \frac{V_{vi} * 530[P_b + \Delta h/13.6]}{T_{vi} * 29.92} \qquad \textbf{Equation 9.1}$$

Where:

V_{vsi} = Total volume of vapors discharged through the "i-th" vent pipe, corrected to 70^0F (530^0R) and 29.92" Hg, SCF
P_b = Barometric pressure, inches Hg
V_{vi} = Total volume of vapors discharged through the "i-th" vent; ACF
T_{vi} = Average temperature in "i-th" vent line, ^{0}R
Δh = Average pressure at meter, inches H_20
13.6 = Inches of water per inch of mercury
i = Vent under consideration

9.2 The volume of vapors returned to the cargo tank shall be calculated as follows:

$$V_t = \left[\frac{(G_t)\left(530\left(\frac{P_b + \Delta h}{13.6}\right)\right)}{(T_t)(29.92)(7.481)} \right] \qquad \text{Equation 9.2}$$

Where:

V_t = Volume of vapors returned to the cargo tank corrected to 70^0F (530^0R) and 29.92" Hg, SCF
G_t = Volume of gasoline delivered, gallons
Δh = Final gauge pressure at cargo tank, in. H_2O
T_t = Average temperature of vapors returned to cargo tank, ^{o}R
P_b = Barometric pressure, inches Hg
13.6 = Conversion factor, inches of water column per inch of mercury
530 = Temperature, ^{o}R
7.481 = Conversion factor; gallons to ft^3

9.3 The collection efficiency shall be calculated as follows:

$$E = 100\left[\frac{V_t - V_{vsi}}{V_t}\right] \qquad \textbf{Equation 9.3}$$

Where:

E = Phase I Volumetric Efficiency, percent
V_t = From 9.2
V_{vsi} = From 9.1

10. REPORTING RESULTS

10.1 Results shall be reported as shown on Form 4.

11. ALTERNATE PROCEDURES

11.1 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 ARB Executive Officer, pursuant to Section 14 of Certification Procedure CP-201.

Form 1

PHASE I VAPOR RECOVERY DATA SHEET

Station:	Address:	City:
Contact:	Phone:	Date:
Number of Underground Tanks:	Number of Vent Pipes:	

TEST SEQUENCE	1	2	3	4
1. Ambient Temperature, ^{o}F				
2. Barometric Pressure, inches of Hg				
3. Gasoline Grade				
4. U.G. Tank Size, gallons				
5. Initial U.G. Tank Content, gal.				
6. Time Delivery Began				
7. Beginning Vent Meter Reading				
8. U.G. Tank Vapor Temperature, ^{o}F				
9. Vent Vapor Temperature, ^{o}F				
10. Vent Meter Pressure, inches of water				
11. Volume Delivered, gallons				
12. Time Delivery Ended				
13. Ending Vent Meter Reading				
14. Drop Flowrate, gallons/minute				
15. Volume of Vent Emissions , scf				
16. Volume of Vapor Returned to Cargo Tank, scf				
VAPOR RECOVERY EFFICIENCY, %				

$$\text{Efficiency} = \left(\frac{\#16 - \#15}{\#16} \right) x100$$

TEST PERSONNEL: _____

COMPANY NAME: _____

COMPANY ADDRESS: _____

_____

Form 2

PHASE I VENT PIPE DATA SHEET

Station	Address	City
GDF#	Contact	Phone
Date	Test Times	Manifolded (Y/N)

Drop#				Drop#				Drop#			
Grade(s)				Grade(s)				Grade(s)			
Gallons				Gallons				Gallons			
Time	Meter Reading	ΔP	Temp °F	Time	Meter Reading	ΔP	Temp °F	Time	Meter Reading	Δ P	Temp °F
0 sec				0 sec				0 sec			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
1 min				**1 min**				**1 min**			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
2 min				**2 min**				**2 min**			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
3 min				**3 min**				**3 min**			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
4 min				**4 min**				**4 min**			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
5 min				**5 min**				**5 min**			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
6 min				**6 min**				**6 min**			
15 sec				15 sec				15 sec			
30 sec				30 sec				30 sec			
45 sec				45 sec				45 sec			
7 min				**7 min**				**7 min**			

Form 3

PHASE I CARGO TANK DATA SHEET

Station	Address	City
GDF#	Contact	Phone
Date	Test Times	Manifolded (Y/N)

Drop#			Drop#			Drop#		
C. T. #			C. T. #			C. T. #		
CARB Decal #			CARB Decal #			CARB Decal #		
Decal Expires			Decal Expires			Decal Expires		
C. T. Capacity			C. T. Capacity			C. T. Capacity		
Grade(s)			Grade(s)			Grade(s)		
Gallons			Gallons			Gallons		
Time	ΔP	Temp °F	Time	ΔP	Temp °F	Time	ΔP	Temp °F
0 sec			0 sec			0 sec		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
1 min			**1 min**			**1 min**		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
2 min			**2 min**			**2 min**		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
3 min			**3 min**			**3 min**		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
4 min			**4 min**			**4 min**		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
5 min			**5 min**			**5 min**		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
6 min			**6 min**			**6 min**		
15 sec			15 sec			15 sec		
30 sec			30 sec			30 sec		
45 sec			45 sec			45 sec		
7 min			**7 min**			**7 min**		

Form 4

Distribution: (for internal use only)	**Air Agency** **Summary of Source Test Results**	**Report No.:** _____ **Test Date:** _____ **Test Times:** **Run A:** _____ **Run B:** _____ **Run C:** _____

Source Information		**Air Representatives**
Company Name and Address	Company Representative and Title Phone No. ( )	Source Test Engineers
Permit Conditions:	Source: Plant No. Permit No. Operates Hr/Day & Day/Yr.	Other Test Requested By:
Operating Parameters		
Applicable Regulations:		VN Recommended:

Source Test Results and Comments:

METHOD	DROP #1	DROP #2	DROP #3	LIMIT
TP-201.1				
GASOLINE GRADE				
GALLONS DELIVERED				
VENT PIPE EXHAUST, SCF				
VAPORS RETURNED TO CARGO TANK, SCF				
PHASE I VOLUME EFFICIENCY, VOLUME %				98.0*

* Each bulk gasoline drop is subject to this standard.

Test Engineer II Date	Supervising Engineer Date	Approved by Engineering Manager