California Environmental Protection Agency

Air Resources Board

Vapor Recovery Test Procedure

TP-201.1

Volumetric Efficiency for Phase I Vapor Recovery Systems

Adopted: April 12, 1996
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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" or "CARB" refers to the 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

The purpose of this procedure is to quantify the transfer efficiency when a bulk gasoline delivery between a cargo tank and underground storage tank is made. This procedure is used to determine compliance with Phase I performance standard specified in Certification Procedure 201 (CP-201).

2. PRINCIPLE AND SUMMARY OF TEST PROCEDURE

During a gasoline delivery, the cargo tank and gasoline dispensing facility (GDF) are instrumented with test equipment in order to determine the amount of vapor returned to the cargo tank and the amount of vapor discharged through the GDF vent pipe. From these parameters the Phase I volumetric efficiency is determined. This procedure provides for determining efficiency by way of either direct measurement or calculation.

If a Phase I system fails to meet the volumetric efficiency as required by CP-201, the cargo tank shall be tested for compliance with the daily standards established for cargo tanks as specified in CP-204 to determine if the failure can 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 daily pressure-decay standards as defined in CP-204 preclude the use of this method.

3.3 The presence of vapor leaks in the GDF, greater than the allowable leak decay limits specified in Section 3.2 of CP-201 preclude use of this method.

3.4 Unusually large cargo tank headspace volumes may cause low volumetric efficiency under certain conditions. Conversely, unusually small cargo tank headspace volumes may result in unusually high efficiency. 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, PRECISION AND RANGE

4.1 Mechanical Pressure Gauge. The minimum readability shall be 1.00 inches H_2O with a maximum full-scale range of 30 inches H_2O and minimum accuracy of three percent of full scale. Pressure gauges with a higher resolution and higher accuracy may be deemed acceptable with prior approval by the Executive Officer.

4.2 Electronic Pressure Gauge. The maximum full-scale range of the device shall not exceed 20 inches H_2O with minimum sensitivity of 1.00 inches H_2O and minimum accuracy of 0.5 percent of full scale. Electronic pressure gauges shall be calibrated as described in Section 5 of this procedure.

4.3 Volume Meter, Vapor Return. Minimum full-scale range shall be 5,000 CFH with a maximum rated back pressure less than 1.10 in H_2O. The meter shall have an internal diameter of 3 inches, equal to that of a cargo tank vapor return hose.

4.4 Volume Meter, Vent Pipe. Minimum full-scale range shall be 800 CFH with a maximum rated back pressure less than 0.26 in H_2O. The meter shall have an internal diameter of 2 inches, equal to that of a GDF vent pipe.

4.5 Temperature. Maximum range of 0 to 150°F and accurate to within 2°F.

4.6 Barometric Pressure. Minimum accuracy of .08 inches of mercury (1.0 inch H_2O or 2.7 millibar).

5. EQUIPMENT

5.1 Vapor Return Meter(s). Use a volume meter with minimum specifications described in Section 4 to measure the amount of vapor returned to the cargo tank from the underground storage tank. The meter shall be equipped with a pressure gauge and temperature device as described in Section 4 on the inlet side. The meter shall be connected to the GDF in a fashion as to maintain intrinsic safety, see Figure 3.

5.2 Vent Pipe Meter. Use a volume meter with minimum specifications described in Section 4 to measure the amount of vapor discharged through the vent pipe(s). The meter shall be equipped with a pressure gauge and temperature device as described in Section 4 on the inlet side. The meter shall be connected to the GDF in a fashion as to maintain intrinsic safety, see Figure 3.

5.3 Cargo Tank Back Pressure Assembly. When testing Phase I efficiency without the use of volume meters, use OPW® 633-F and 633-D couplers, or equivalent, as shown in Figure 1. The assembly shall be equipped with a pressure gauge capable of measuring up to 30 inches H_2O back pressure at the gasoline cargo tank vapor

coupler. Temperature may be measured at this point as an alternate to, or in addition to 5.1.

5.4 Storage Tank Pressure Assembly. When testing Phase I efficiency with the cargo tank back pressure assembly and the test facility uses a two point Phase I system with storage tanks manifolded underground, use OPW® 634-B cap(s) or equivalent, equipped with a pressure gauge and center probe as shown in Figure 2

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 with minimum specifications described in Section 4 to measure the barometric pressure during testing. The result shall be used to correct the volume of vapor returned or discharged.

5.7 Temperature. Use a minimum of three thermometers, Thermocouples™, or equivalent, to measure the vapor temperature at each meter. The results shall be used to correct the volume of vapor returned or discharged.

5.8 Stopwatch. Use a stopwatch accurate to within 0.1 seconds to time the delivery rate.

6. PRE-TEST PROCEDURES

6.1 The volume meter(s) shall be proofed against a standard reference meter prior to its initial use in the field or at intervals not to exceed 180 days. Calibration shall be performed at a minimum of three flowrates representing 25, 50 and 75 percent of rated capacity. An official statement of proofing is required.

6.2 The GDF shall be pre-tested for leak integrity as described in TP-201.3 at least 24 hours prior, and no longer than 7-days before testing. If a manifold is to be used at the vent pipe, the manifold shall be installed prior to conducting leak integrity testing.

6.3 No product dispensing shall occur for a minimum of 30 minutes prior to testing.

6.4 Taking caution to avoid venting the storage tanks, connect the vent pipe meter(s) to the appropriate storage tank vent pipe(s) with the inlet side attached to the vent pipe. Use a metal ball valve if required to avoid venting. Attach the PV valve(s) to the outlet side of the meter(s) using a threaded nipple or equivalent. A temporary manifold may be constructed of steel where all vent pipes are connected to a single outlet and a single meter is installed.

6.5 Taking caution to avoid venting the storage tanks, connect the vapor return meter(s) to the appropriate Phase I vapor connection(s) using metal fittings in order to maintain intrinsic safety. Use a metal vapor poppet if required to avoid venting. Connect the cargo tank vapor return hose to the outlet side of the meter. The meter will be in line between the Phase I connection and the cargo tank vapor return hose.

6.6 With no product dispensing, record the product grade, tank capacity, tank temperature and ambient conditions on the data sheet where provided.

6.7 If used, connect the Cargo Tank Back Pressure Assembly to the vapor coupler on the cargo tank. This assembly will be in line with the cargo tank vapor recovery hose. If the cargo tank vapor coupler is equipped with a poppet, use a pressure assembly with center probe.

6.8 If the cargo tank back pressure assembly is being used, install a Storage Tank Pressure Assembly on each Phase I vapor connection of those tanks not receiving product. During each bulk drop, record the maximum pressure in those tanks.

6.9 Record the product quantities to be delivered during each bulk drop. Also record the cargo tank CARB decal number and delivery company name on the data sheet where provided.

6.10 Stabilization. Open the corresponding cargo tank internal vapor valve(s) prior to delivering product. Once the vapor valve(s) is opened, wait a period of at least 1-minute to allow for pressure stabilization between the UST and cargo tank.

7. TESTING

7.1 Record the stabilized, vapor return and vent pipe meter reading(s) on the data sheet where provided.

7.2 Start the gasoline bulk drop. Using the stopwatch, time each gasoline drop to determine the delivery rate for each compartment.

7.3 At minimum, record the following parameters for each gasoline bulk drop:

7.3.1 Initial and final meter readings for each vapor return meter

7.3.2 Average vapor return pressure

7.3.3 Average vapor return temperature

7.4 Repeat Sections 7.1 through 7.3 for each gasoline delivery. For deliveries using different Phase I connections (i.e., different storage tanks), relocate the vapor return meter(s) to the appropriate storage as specified in Section 6.7.

7.5 At conclusion of all gasoline deliveries, ensure that each of the cargo tank internal vapor valve is closed prior to disconnecting. Disconnect the vapor return meter(s) from the storage tank(s) taking care to avoid venting pressure. Disconnect the vapor return hose from the outlet side of the vapor return meter.

7.6 Continue to monitor the vent pipe meter for a minimum of 15 minutes. If the UST pressure is less than 1.00 inches H_2O, testing may be concluded. In the event that the station UST pressure is greater than 1.00 inches H_2O, continue to monitor the

vent pipe meter for an additional 45 minutes (1-hour total). These measurements are to be included in the Phase I efficiency calculation.

8. POST TEST PROCEDURES

8.1 At conclusion of the bulk delivery, ensure that each of the cargo tank internal vapor valves is closed prior to removing connections.

8.2 Remove the Cargo Tank Back Pressure Assembly, if used, from the cargo tank vapor return coupler.

8.3 Remove the Storage Tank Pressure Assembly, if used, from each storage tank where installed.

8.4 Remove the temporary manifold (if constructed) and disconnect all instrumentation from the vent pipe area. Replace the PV valve(s) on the vent pipe(s).

8.5 Verify the quantity of gasoline delivered to each storage tank using the facility tank gauge monitor or with use of a tank gauging stick.

8.6 The static pressure integrity of the vapor recovery system shall be verified as described in TP 201.3 as soon as possible, but not more than 48 hours, after the completion of this test. Failure of the static pressure integrity test shall invalidate the TP-201.1 test results unless the Executive Officer determines that the integrity failure did not result in any significant unmeasured emissions**.**

9. CALCULATING RESULTS

9.1 The measured volume of vapor passed through the vapor return to the cargo tank and vent pipe shall be corrected to standard conditions as follows:

$$V_{corr} = \frac{(V_{vi})(528)[Pb + \Delta h/13.6]}{(T_{vi})(29.92)} \qquad \textbf{Equation 9.1}$$

Where:

V_{corr} = Volume of vapor, corrected to 68^0F (528^0R) and 29.92" Hg
P_b = Barometric Pressure, inches Hg
V_{vi} = Uncorrected volume of vapor (raw meter reading)
T_{vi} = Average or venting temperature at vent meter, ^{0}R
Δh = Average or venting pressure at vent meter, inches H_2O
13.6 = Inches of water per inch of mercury
528 = Standard ambient temperature, 68^0F converted to degrees Rankine

9.2 If a cargo tank back pressure assembly was used to conduct testing, the volume of vapor returned to the cargo tank shall be calculated to standard conditions as follows:

$$V_t = \left[\frac{(0.1337)(G_t)\left(528\left(P_b + \frac{\Delta h}{13.6}\right)\right)}{(T_t)(29.92)} \right] \qquad \textbf{Equation 9.2}$$

Where:

V_t = Calculated volume of vapor returned to cargo tank corrected to 68^0F (528^0R) and 29.92" Hg
G_t = Volume of gasoline delivered, gallons
Δh = Final gauge pressure at cargo tank, in. H_2O
T_t = Average temperature of vapor returned to cargo tank, ^{o}R
P_b = Barometric pressure, inches Hg
13.6 = Inches of water per inch of mercury
528 = Standard ambient temperature, 68^oF converted to degrees Rankine

9.3 The collection efficiency shall be calculated as follows:

$$E = (100)\left[\frac{V_{returned} - V_{vent}}{V_{returned}} \right] \qquad \textbf{Equation 9.3}$$

Where:

E = Phase I Volumetric Efficiency, percent
$V_{returned}$ = Vapor Return: From 9.1(V_{corr}) or 9.2(V_t)
V_{vent} = Corrected Vent Pipe Discharge: From 9.1(V_{corr})

10. REPORTING RESULTS

10.1 Results shall be reported as shown on the data sheets where provided. Districts may require the use of alternate data sheets provided they include, at minimum, the same parameters identified on Form 1.

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
ARB TP-201.1

Test Date: _____ Observations By: _____

Facility Name: _____

Address: _____

System Description: _____

Time: _____ Ambient Temp: _____ deg F Barometric: _____ Hpa

Wind: _____ mph Altitude: _____ ft Other: _____

Cargo Tank Company: _____

Cargo Tank Decal #(s): Truck: _____ Trailer: _____

Compartment #1

Pre-Delivery Observations		Delivery Observations	
		Tank Orientation:	
Initial UST Product Temerature:	deg F	Delivered Product Temperature:	deg F
UST Size:	gal	Avg Vapor Return Pressure:	inWC
Amount To Deliver (BOL):	gal	Avg Vapor Return Temp:	deg F
Grade: _____ Loading Temp (BOL):		Fuel RVP (BOL):	
Initial Meter Reading:	ft^3	**Final Meter Reading:**	ft^3

Compartment #2

Pre-Delivery Observations		Delivery Observations	
		Tank Orientation:	
Initial UST Product Temerature:	deg F	Delivered Product Temperature:	deg F
UST Size:	gal	Avg Vapor Return Pressure:	inWC
Amount To Deliver (BOL):	gal	Avg Vapor Return Temp:	deg F
Grade: _____ Loading Temp (BOL):		Fuel RVP (BOL):	
Initial Meter Reading:	ft^3	**Final Meter Reading:**	ft^3

Compartment #3

Pre-Delivery Observations		Delivery Observations	
		Tank Orientation:	
Initial UST Product Temerature:	deg F	Delivered Product Temperature:	deg F
UST Size:	gal	Avg Vapor Return Pressure:	inWC

Compartment #4

Pre-Delivery Observations		Delivery Observations	
		Tank Orientation:	
Initial UST Product Temerature:	deg F	Delivered Product Temperature:	deg F
UST Size:	gal	Avg Vapor Return Pressure:	inWC
Amount To Deliver (BOL):	gal	Avg Vapor Return Temp:	deg F
Grade:	Loading Temp (BOL):	Fuel RVP (BOL):	
Initial Meter Reading:	ft^3	**Final Meter Reading:**	ft^3

Compartment #5

Pre-Delivery Observations		Delivery Observations	
		Tank Orientation:	
Initial UST Product Temerature:	deg F	Delivered Product Temperature:	deg F
UST Size:	gal	Avg Vapor Return Pressure:	inWC
Amount To Deliver (BOL):	gal	Avg Vapor Return Temp:	deg F
Grade:	Loading Temp (BOL):	Fuel RVP (BOL):	
Initial Meter Reading:	ft^3	**Final Meter Reading:**	ft^3

Vent Pipe Discharge

Delivery Observations		Post Delivery Observations	
Initial Vent Pressure:	inWC	Post Observation Time:	
Initial Vent Temperature:	deg F		
Initial Meter Reading:	ft^3	Remarks:	
		Final Vent Pressure:	inWC
Stack Venting Pressure:	inWC	Final Vent Temperature:	deg F
Stack Venting Temperature:	deg F	**Final Meter Reading:**	ft^3

Figure 1 - Cargo Tank Back Pressure Assembly

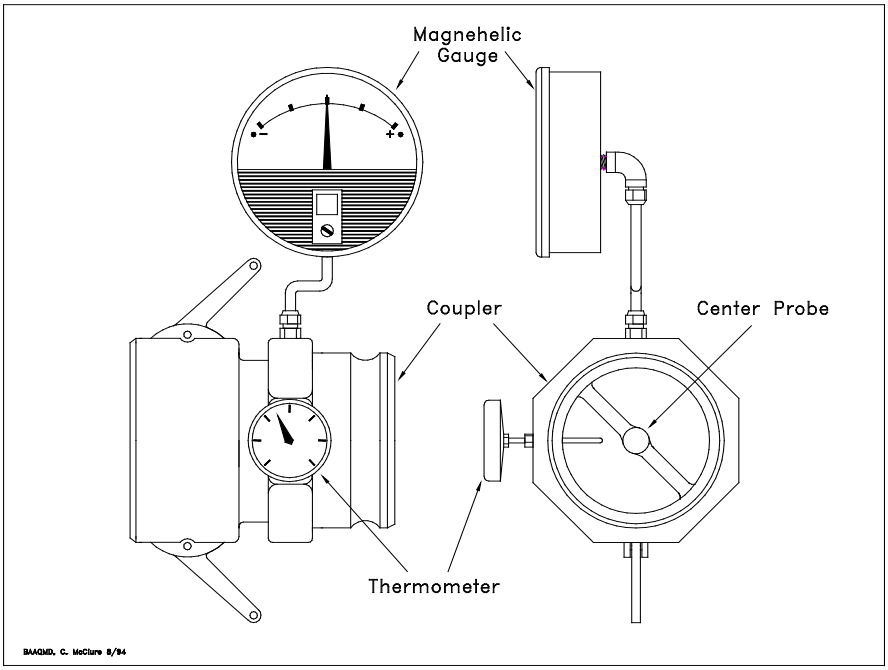

Figure 2 - Storage Tank Pressure Assembly

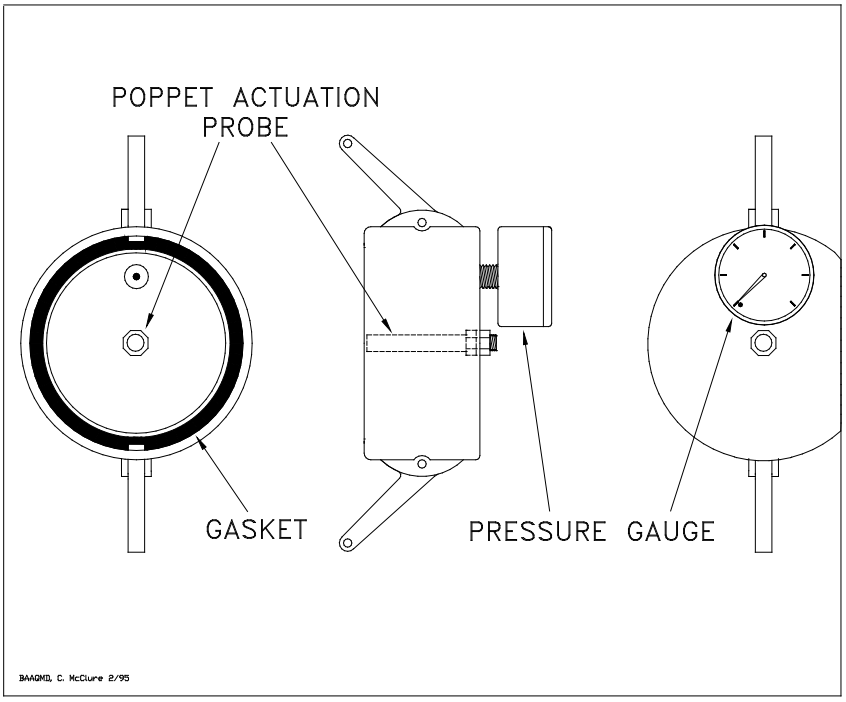

Figure 3 - Vent Pipe and Vapor Return Meter Arrangement

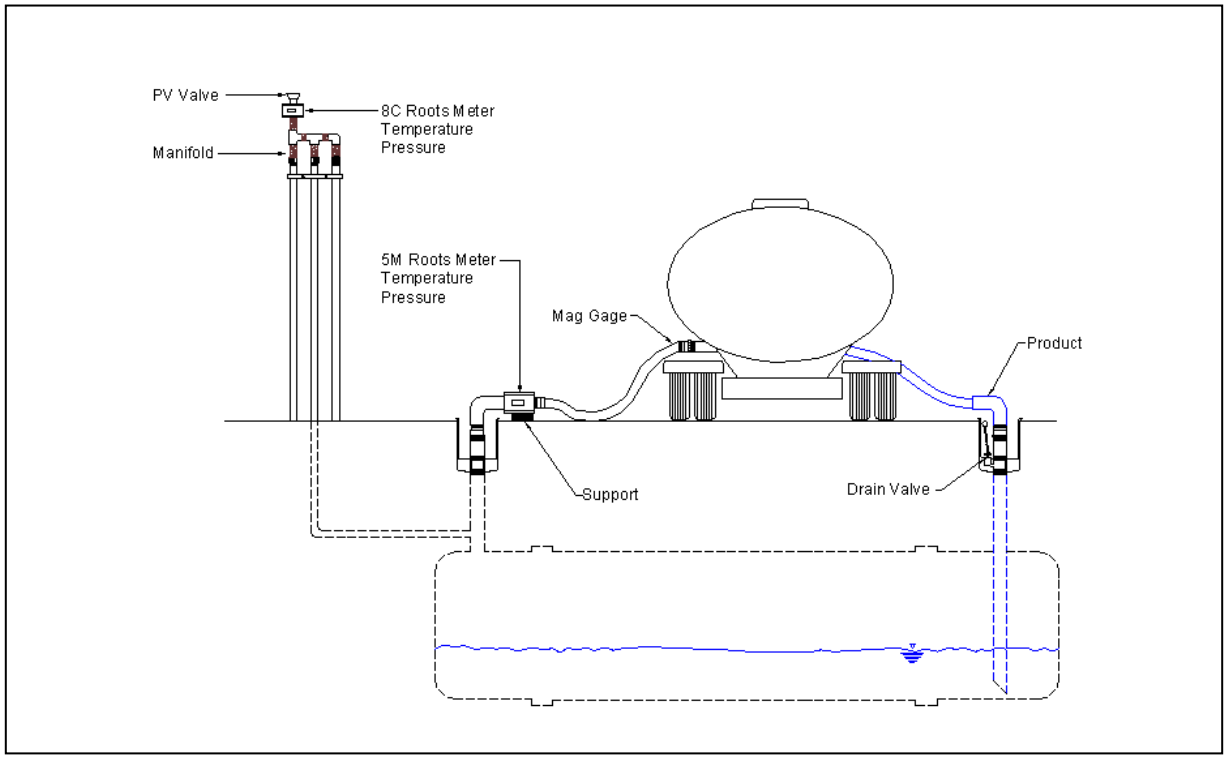

Figure 4 - Example of A Steel Vent Pipe Manifold