

California Environmental Protection Agency

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# **Air Resources Board**

**Vapor Recovery Test Procedure**

**TP-201.1**

**Determination of Efficiency of  
Phase I Vapor Recovery Systems of  
Dispensing Facilities without  
Assist Processors**

**Adopted: April 12, 1996**

California Environmental Protection Agency  
Air Resources Board

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Dispensing Facilities without  
Assist Processors

**1 APPLICABILITY**

A set of definitions common to all certification and test procedures is in:

**D-200** Definitions for  
Certification Procedures and  
Test Procedures for  
Vapor Recovery Systems

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

**1.1 General Applicability**

This procedure is used to quantify the Phase I volumetric efficiencies during bulk gasoline deliveries at gasoline distribution facilities (GDF). It is applicable for the determination of compliance at those facilities which are not equipped with an assist processor (e.g. Hirt or Hasstech Phase II systems are equipped with an assist processor). Assist systems actively pump vapors to processors which control emissions by burning, adsorbing, or condensing hydrocarbon vapors. The active pump in the system and the emissions point at the processor outlet in addition to the vent require additional steps in the test procedure.

**1.2 Modifications**

Modification of this procedure may be necessary for vapors and fluids other than the hydrocarbon vapors associated with the dispensing of gasoline.

Any modification of this method shall be subject to approval by the ARB Executive Officer.

## 2 PRINCIPLE AND SUMMARY OF TEST PROCEDURE

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 95% volumetric efficiency, the gasoline cargo tank shall be tested, pursuant to TP-204.2, to determine compliance with the daily performance standards for gasoline cargo tanks. For this application, TP-204.1 and TP-204.3 are inappropriate.

## 3 BIASES AND INTERFERENCES

### 3.1 Bulk Delivery Vapor Leaks

Any vapor leak exceeding 21,000 ppm (as propane), during the gasoline bulk delivery, precludes the use of this method.

### 3.2 Cargo Tank Performance

Gasoline cargo tanks exceeding the static pressure performance standards (see CP-204) preclude the use of this method.

## 4 SENSITIVITY, RANGE, AND PRECISION

The minimum readability of the pressure gauges shall be 0.1 inches of water column.

The minimum accuracy of the pressure gauges shall be 2 % of full scale.

## 5 EQUIPMENT

### 5.1 Positive Displacement Meter(s)

Use rotary type positive displacement meter(s) with a back pressure limit (BPL) less than:

1.10 inches water column at a flowrate of 3,000 CFH down to  
0.05 inches water column at a flowrate of 30.0 CFH.

Meter(s) shall be equipped with taps accomodating the following equipment:

(1) taps on the inlet side for

(a) a thermocouple with a range of 0 to 150 °F and

- (b) a pressure gauge with a range providing absolute pressure readings within 10 to 90% of the range (more than one gauge shall be used, if necessary) and
- (2) taps on the inlet and outlet sides for a differential pressure gauge with a range of 0 to  $< 2x$  BPL (i.e. full scale shall be less than twice the back pressure limit).

## 5.2 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 Civicon 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 water column 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 water column 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.

## 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 5 millimeters of mercury ( 0.2 inches of mercury ).

## 5.7 Thermometers

Use three thermometers, or equivalent, with a range of 0 to 150 °F and accurate to within 2 °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 CALIBRATION PROCEDURE**

A record of all calibrations shall be maintained.

### **6.1 Analyzers**

Follow the manufacturer's instructions concerning warm-up time and adjustments. On each test day prior to testing, zero the analyzer with a zero gas and span with a known concentration of calibration gas at a level near the highest concentration expected. Perform an intermediate zero and span calibration approximately 2 hours after the initial calibration and at any time a calibration drift is evident. Check for zero and span calibration drift at the end of the test period. All calibrations and adjustments shall be documented.

### **6.2 Volume Meters**

Meters shall be calibrated on an annual basis.

### **6.3 Pressure Transducers**

Calibrate pressure transducers prior to testing and immediately following the test period with a static pressure calibrator for a range of -3 to +3 inches water or appropriate range of operation.

### **6.4 Temperature Transducers**

Calibrate temperature transducers every six months using ambient air, the temperature of which is determined by a NIST traceable mercury-glass thermometer.

## **7 PRE-TEST PROTOCOL**

### **7.1 Location of Test Site**

Prototype systems will be located within 100 miles of Sacramento for testing. Other locations may be accepted at the discretion of the ARB Executive Officer.

### **7.2 Specification of Test, Challenge, and Failure Modes**

The specification of test, challenge, and failure modes such as the number of liquid transfer episodes, volume and volumetric rate of liquid transfer, storage tank volumes, etc. shall be done according to the principles of CP-201 § 5 for the testing and evaluation of vapor recovery equipment.

### **7.3 System and Facility Preparation**

System equipment and components shall be completely operational and any storage tanks involved in the test shall be filled to the appropriate volume a minimum of 24 hours prior to the scheduled test.

In addition, the system and facility shall be prepared to operate according to any specified test, challenge, and failure modes.

### **7.4 Specific Pre-Test Protocol Items**

#### **(1) Visual Inspection**

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

#### **(2) Meter Connections**

Connect the positive displacement meter to the appropriate storage tank vent pipe using the flexible tubing. If a non-manifolded delivery consists of simultaneous delivery of more than one product grade, connect one positive displacement meter to each storage tank vent pipe.

#### **(3) Phase I Vapor Recovery Data Sheet**

- (a) Record the gas grade, capacity, and ullage for each storage tank on the Phase I Vapor Recovery Data Sheet shown in Figure 3.
- (b) Record, on the Phase I Vapor Recovery Data Sheet, the initial meter readings from the positive displacement meter.
- (c) Record, on the Phase I Vapor Recovery Data Sheet, the barometric pressure.

#### **(4) Cargo Tank Vapor Assembly Connection**

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, be sure to use a pressure assembly with a center probe.

#### **(5) Storage Tank Pressure Assembly Connection**

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 systems the pressure may be measured at the dispensers.

### **7.5 Ensure that no vehicle refueling will occur during the bulk gasoline delivery.**

## 8 TEST PROCEDURE

The facility and system shall be prepared to operate according to any specified test, challenge, and failure modes.

### 8.1 General Data Collection

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

### 8.2 Chronometric Data

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

### 8.3 Data Collection

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

#### 8.3.1 Phase I Vent Pipe Data Sheet

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 shown in Figure 4.

#### 8.3.2 Phase I Cargo Tank Data Sheet

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 shown in Figure 5.

### 8.4 Continuous Monitoring

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 § 8.3.1 shall be recorded at 5 minute intervals. These emissions are to be included in the Phase I efficiency calculation.

### 8.5 After the Bulk Drop

After the conclusion of the bulk drop:

- (1) remove the Cargo Tank Pressure Assembly from the cargo tank and the Storage Tank Pressure Assembly(s) from the storage tank(s);

- (2) disconnect all instrumentation from the storage tank vent pipe(s) after concluding the one hour post-drop portion of the test;
- (3) verify the quantities of gasoline delivered to each storage tank;
- (4) record the final meter reading(s) at the storage tank vent pipe(s).

**9 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)**

This section is reserved for future specification.

**10 RECORDING DATA**

This section is reserved for future specification.



## 11 CALCULATING RESULTS

**Note:** In addition to other required calculations, vapor recovery system test results shall be calculated in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

### 11.1 Volume of Vapors Discharged through "i<sup>th</sup>" Vent

This includes the storage tank vent(s) and any control system vent(s).

$$V_{vsi} = \frac{V_{vi} \times 528 \left[ P_b + \frac{\Delta h}{13.6} \right]}{T_{vi} \times 29.92}$$

Where:

$V_{vsi}$  = total volume of vapors discharged through the "i-th" vent pipe, corrected to 68°F 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; °R

$\Delta h$  = average pressure at meter; inches H<sub>2</sub>O and

$i$  = vent under consideration.

### 11.2 Volume of Vapors Returned to the Cargo Tank:

$$V_t = \frac{0.1337 \times G_t \times 528 \left[ P_b + \frac{\Delta H}{13.6} \right]}{T_t \times 29.92}$$

Where:

$V_t$  = volume of vapors returned to the cargo tank corrected to 68°F and 29.92" Hg; SCF.

$G_t$  = volume of gasoline delivered; gallons.

$\Delta H$  = final gauge pressure at cargo tank; in. H<sub>2</sub>O.

$T_t$  = average temperature of vapors returned to cargo tank; °R.

$P_b$  = barometric Pressure; inches Hg.

0.1337 = conversion factor; gallons to ft<sup>3</sup>.

### 11.3 Collection Efficiency

$$E = \frac{V_t - V_{vsi}}{V_t} \times 100$$

Where:

$E$  = Phase I volumetric efficiency; percent.

$V_t$  = see 11.2.

$V_{vsi}$  = see 11.1.

## 12 REPORTING RESULTS

**Note:** In addition to other required results, vapor recovery system test results shall be reported in units of pounds of hydrocarbon emitted per thousand gallons of fuel transferred for any results which are expressible in such units.

Results shall be reported as shown in Figure 6.

## 13 ALTERNATIVE TEST PROCEDURES

Test procedures, other than specified above, shall only be used if prior written approval is obtained from the ARB Executive Officer. In order to secure the ARB Executive Officer's approval of an alternative test procedure, the applicant is responsible for demonstrating to the ARB Executive Officer's satisfaction that the alternative test procedure is equivalent to this test procedure.

- (1) Such approval shall be granted on a case-by-case basis only. Because of the evolving nature of technology and procedures for vapor recovery systems, such approval shall not be granted in subsequent cases without a new request for approval and a new demonstration of equivalency.
- (2) Documentation of any such approvals, demonstrations, and approvals shall be maintained in the ARB Executive Officer's files and shall be made available upon request.

**TP-201.1A**      **Determination of  
Efficiency of  
Phase I Vapor Recovery Systems  
with Assist Processors**

This procedure applies when the operation of an assist processor precludes testing by TP-201.1.

## 14 REFERENCES

This section is reserved for future specification.

## 15 EXAMPLE FIGURES AND FORMS

### 15.1 Figures

Each figure provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the figures are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

**Figure 1**  
**Test Locations**

**Figure 2**  
**Storage Tank Test Point 1**  
**Storage Tank Pressure Assembly**

**Figure 3**  
**Vapor Return Test Point 2**  
**Cargo Tank Pressure Assembly**

**Figure 4**  
**Vent Test Point 3**  
**Single Vent (Volume Measurement)**

**Figure 5**  
**Vent Test Point 3**  
**Manifolded Vents (Volume Measurement)**

## 15.2 Forms

Each form provides an illustration of an implementation which conforms to the requirements of this test procedure; other implementations which so conform are acceptable, too. Any specifications or dimensions provided in the forms are for example only, unless such specifications or dimensions are provided as requirements in the text of this or some other required test procedure.

### Form 1

Phase I Vapor Recovery Data Sheet

### Form 2

Phase I Vent Pipe Data Sheet

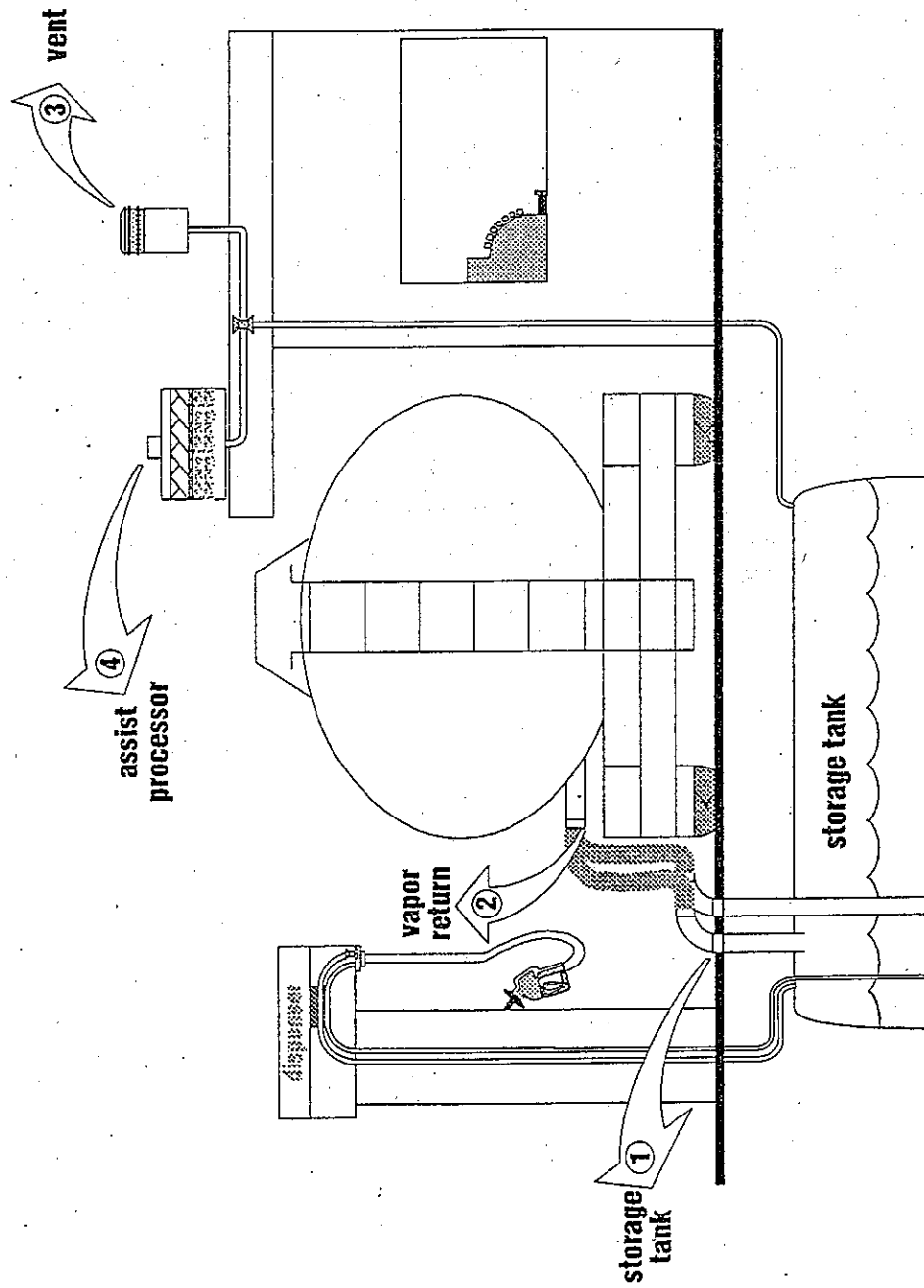
### Form 3

Phase I Cargo Tank Data Sheet

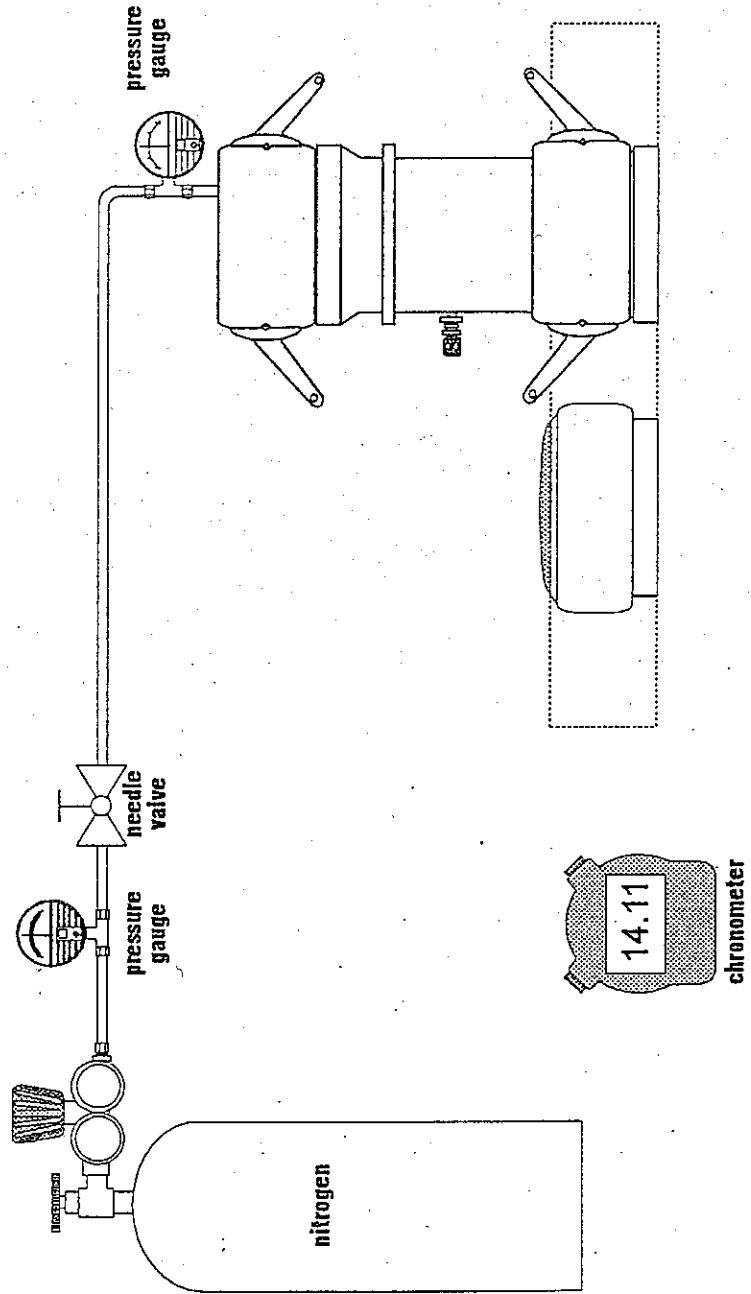
### Form 4

Reporting Results

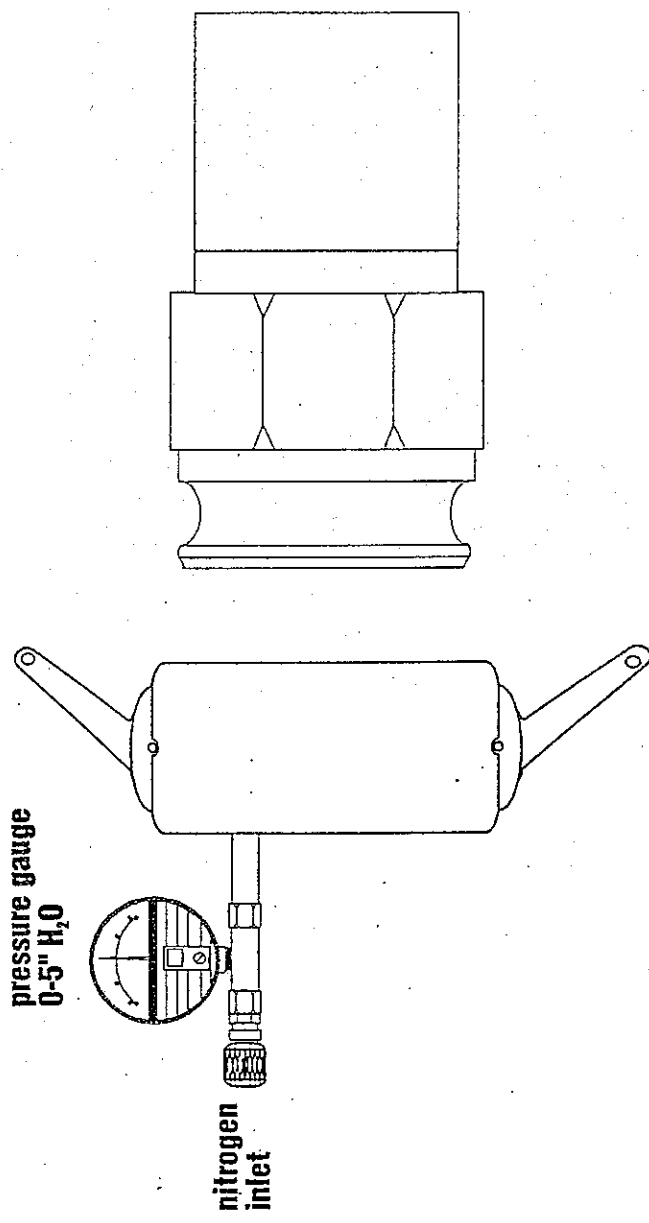
**FIGURE 1**  
**Test Locations**



**FIGURE 2**  
**Storage Tank Test Location 1**  
**Storage Tank Pressure Assembly**

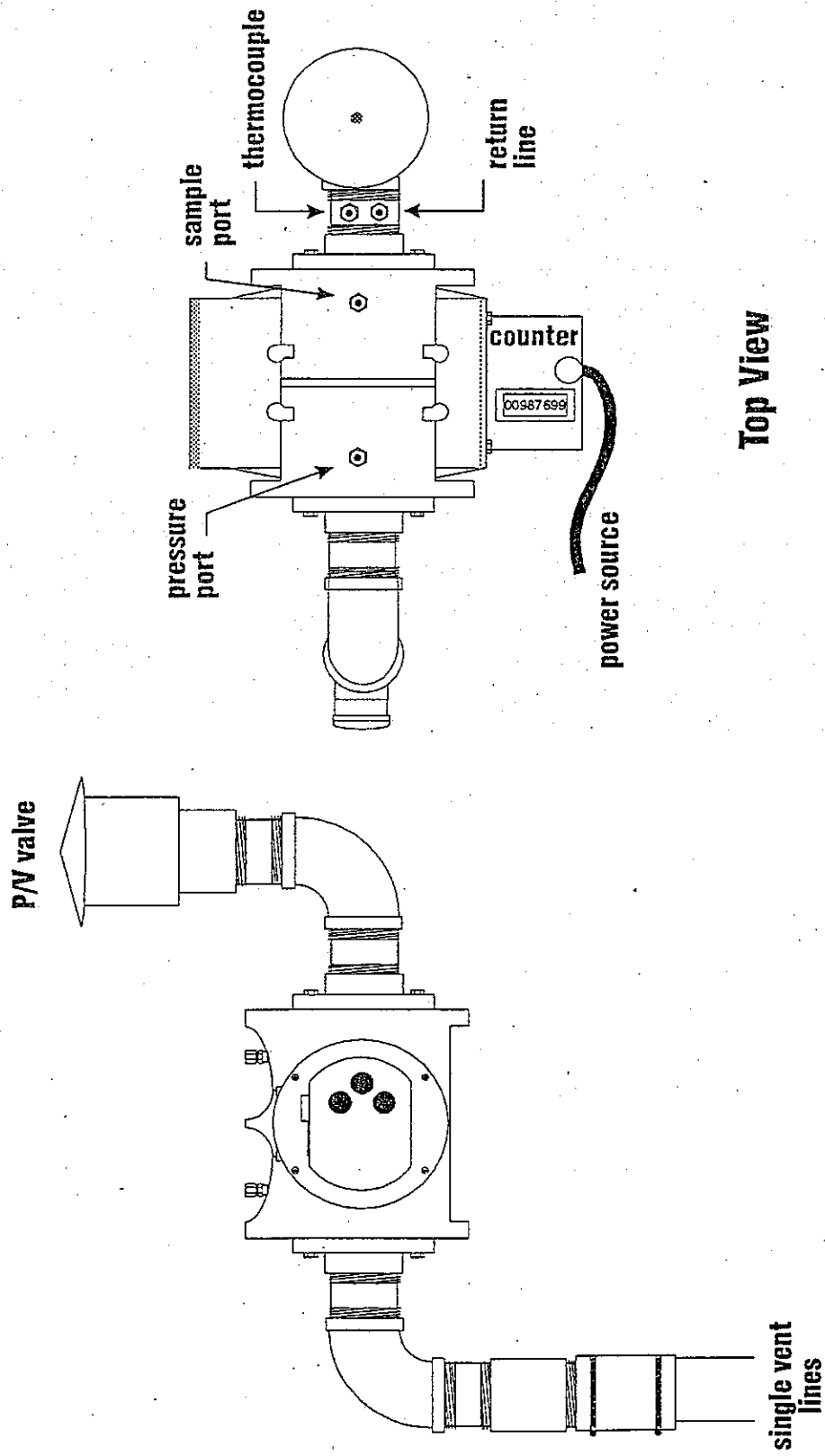


**FIGURE 3**  
**Vapor Return Test Location 2**  
**Cargo Tank Pressure Assembly**



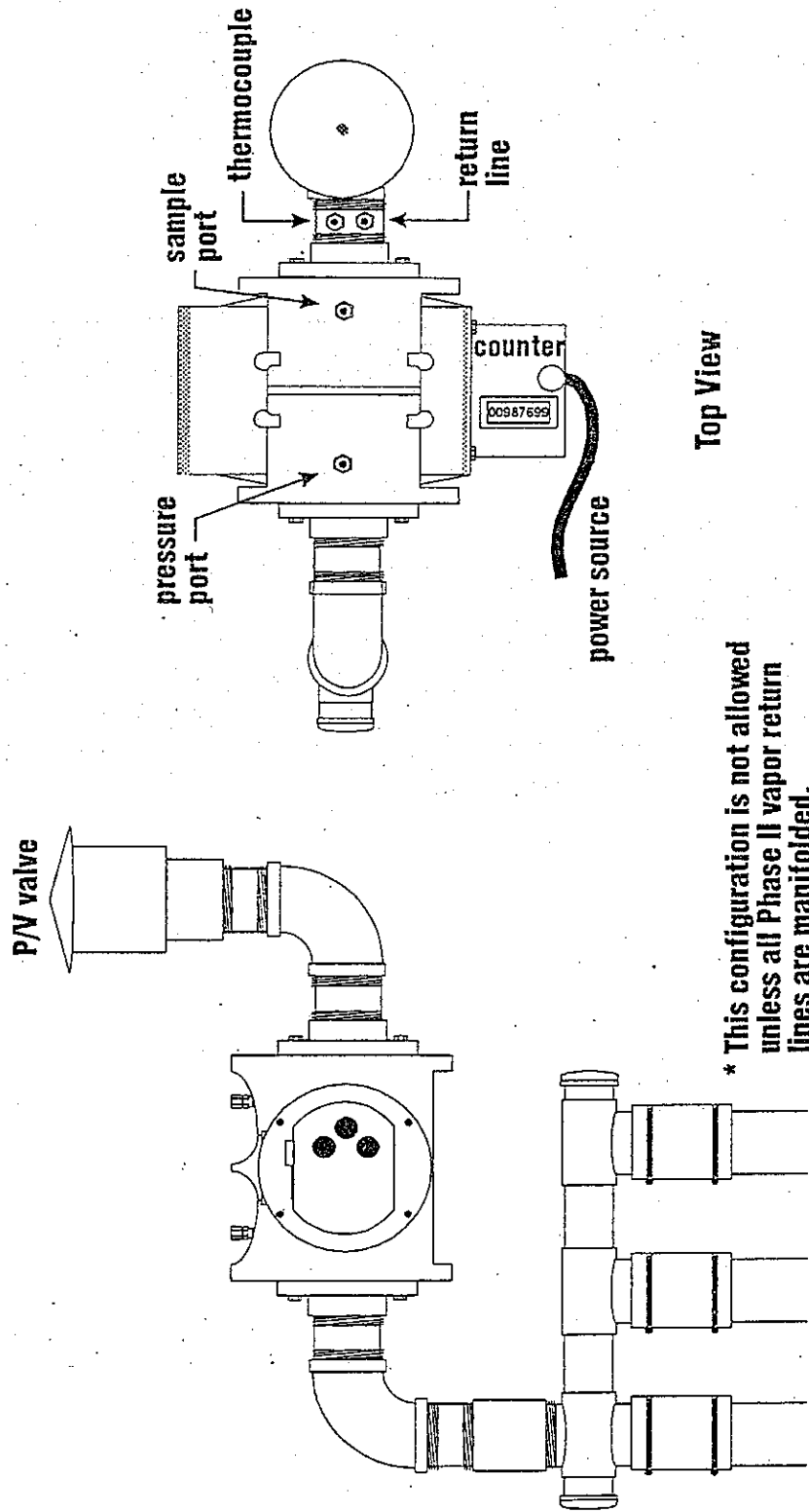


**FIGURE 4**  
**Vent Test Location 3**  
**Single Vent (Volume Measurement)**



TP 201.1 F.4 B. CORDOVA '05

**FIGURE 5**  
**Vent Test Location 3**  
**Manifolded Vents (Volume Measurement)**



manifolded vent lines

# FORM 1

## Phase I Vapor Recovery Data Sheet

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Number of Underground Tanks ..... Vapor Return Manifold (Y/N) ..... ΔP - Dry Bake Closed .....

Number of Vent Pipes ..... Vent Manifold (Y/N) ..... ΔP - Dry Bake Open .....

PARAMETER	TEST NUMBER	1	2	3	4
1. Ambient Temperature, °F					
2. Barometric Pressure, "Hg					
3. Gasoline Grade					
4. U.G. Tank Size, gallons					
5. Initial U.G. Tank Content, gallons					
6. Time Delivery Began/Vent Meter Reading					
7. U.G. Tank Vapor Temperature, °F					
8. Vent Vapor Temperature, °F					
9. Vent Meter Pressure, "H <sub>2</sub> O					
10. Volume Delivered, gallons					
11. Time Delivery Ended/Vent Meter Reading					
12. Drop Flowrate, gallons per minute					
13. Volume of Vent (VOV) Emissions, SCF					
14. Volume of Vapors Returned to Cargo Tank, SCF					
<b>Vapor Recovery Volumetric Efficiency, %</b>					

$$\text{Vapor Recovery Volumetric Efficiency} = \frac{\#14 - \#13}{\#14} \times 100\%$$

TEST PERSONNEL .....

## FORM 2 Phase I Vent Pipe Data Sheet

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Number of Underground Tanks ..... Number of Vent Pipes ..... Test Times .....

Vent Manifold (Y/N) ..... Vapor Return Manifold (Y/N) ..... Vent Valve (Y/N) .....

Bulk Drop ID ..... Grade(s) Dropped ..... Gallons(s) Dropped .....

TIME	V <sub>AIR &amp; VAPOR</sub> SCF	ΔP "H <sub>2</sub> O	T °F	TIME	V <sub>AIR &amp; VAPOR</sub> SCF	ΔP "H <sub>2</sub> O	T °F
1 min				4 min			
2 min				5 min			
3 min				6 min			

TEST PERSONNEL .....

.....

# FORM 3 Phase I Cargo Tank Data Sheet

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Number of Underground Tanks ..... Number of Vent Pipes ..... Test Times .....

Vent Manifold (Y/N) ..... Vapor Return Manifold (Y/N) ..... Vent Valve (Y/N) .....

Bulk Drop ID ..... Grade(s) Dropped ..... Gallons(s) Dropped .....

TIME	V <sub>LIQUID FUEL</sub> GALLONS	$\Delta P$ "H <sub>2</sub> O	TEMP. °F	TIME	V <sub>LIQUID FUEL</sub> GALLONS	$\Delta P$ "H <sub>2</sub> O	TEMP. °F
1 min				4 min			
2 min				5 min			
3 min				6 min			

TEST PERSONNEL .....

.....

# FORM 4 Reporting Results

STATION ID .....

ADDRESS ..... CITY .....

CONTACT ..... PHONE ..... DATE .....

Summary of Test Results for (Phase I Volumetric Efficiency of Service Stations)				
California Environmental Protection Agency, Air Resources Board: Vapor Recovery Test Procedure TP-201.1				
Determination of Efficiency of Phase I Vapor Recovery Systems of Dispensing Facilities without Assist Processors				
Bulk Drop ID				
Volume of Air & Vapor Emitted from Vent, SCF				
Volume of Vapors Returned to Cargo Tank, SCF				
Individual Vapor Recovery Volumetric Efficiency Test Results, %				
Average Vapor Recovery Volumetric Efficiency Test Result, %				
Required Vapor Recovery Volumetric Efficiency, % (by Local Regulation)				
Compliance Status (circle one)			NO	YES

Summary of Attachments	Indicate Absence in this Column	Indicate Number in this Column
Phase I Vapor Recovery Data Sheet(s)		
Phase I Vent Pipe Data Sheet(s)		
Phase I Cargo Tank Data Sheet(s)		
Technical Evaluation and Calculations		
Technical Suggestions for Improved Compliance		